

GAS CHROMATOGRAPHY ABSTRACTS

1958

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(References to the end of 1958)

Compiled and Edited
by

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INTRODUCTION

This collection of abstracts is intended to serve as the Inaugural Volume of 'Gas Chromatography Abstracts', a new publication which will be available for general sale annually, the first volume to be ready early in 1960. This Inaugural Volume covers the period up to the end of 1958, and it is thought to be substantially complete. The first volume proper will cover 1959, and both will be sponsored and prepared for publication by the Gas Chromatography Abstracts Editorial Committee of the Gas Chromatography Discussion Group. The latter Group is associated with the Hydrocarbon Research Group of the Institute of Petroleum.

When this Committee was first formed late in 1958, three members of the Committee had already compiled bibliographies of Gas Chromatography, each consisting of approximately 1,000 references. These three bibliographies were combined and the present collection of abstracts is the result. Its compilation has entailed an enormous amount of work, and whilst every effort has been made to check all references, it is quite possible that some errors may have been overlooked. The Editor would be pleased to be notified of these.

A feature of this volume is the inclusion of a really comprehensive subject index. This has been given careful study by the Committee, and it is hoped that it will be extremely useful. It is believed to be the first detailed subject index to be published on Gas Chromatography.

ACKNOWLEDGEMENTS

We are greatly indebted to the following: —

1. The Chairman and Directors of the British Petroleum Company Ltd. for permission to use the material compiled at the BP Research Centre by Miss Christie, and for library and other facilities granted during the preparation of this work.
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3. Dr. C. J. Hardy for granting permission to incorporate references from a private bibliography, and for his help in many other ways.

In addition, we offer our thanks to all others who have assisted in any way during the preparation of the manuscript, indexing, proof reading and publication.

C. E. H. KNAPMAN
(Editor)

1. The Chromatographic Analysis of Organic Peroxides.
ABRAHAM, M. H., DAVIES, A. G., LLEWELLYN, D. R. and THAIN, E. M.
Anal. Chim. Acta **17** (5) 499-503 (1957). *Chem. Abstr.* **53** 120 (1959).
This estimation can be carried out on silicone treated paper, but peroxides of low molecular weight are lost. These can, however, be identified by gas chromatography using a column of Celite 545 with 30% dinonyl phthalate at 78°C, nitrogen or air as carrier gas and thermal conductivity detection.
2. Sorption and Reactivity of Nitrous Oxide and Nitric Oxide in Crystalline and Amorphous Siliceous Sorbents.
ADDISON, W. E. and BARRER, R. M.
J. Chem. Soc. 1955 757-769. *Chem. Abstr.* **48** 8657 (1955).
Studies on the sorption of NO and N₂O were carried out on Ca- and Na-rich forms of chabazite, faujasite, etc., which had previously been characterised as sorbents by the use of oxygen and argon.
3. An Evaluation of some Polyglycols used as Stationary Phases for Gas-Liquid Partition Chromatography.
ADLARD, E. R.
I.P. Symposium, London, 1956. 98-114.
Ed. DESTY, D. H. Published by Butterworths 1957.
The factors controlling the suitability of a substance for use as a liquid stationary phase are stated and discussed. Several compounds of the polyglycol type have been examined and retention volumes and partition coefficients of many organic compounds obtained.
4. Applications of High Temperature Gas-Liquid Chromatography in the Petroleum Industry.
ADLARD, E. R. and WHITHAM, B. T.
Gas Chromatography 1958. Amsterdam Symposium, May 1958. 351-367.
Ed. DESTY, D. H. Published by Butterworths 1958. Discussion 367-368.
The equipment used for the analysis and separation of substances of low volatility is briefly discussed. The separation of samples containing methyl esters of fatty acids up to C₃₅ and paraffinic hydrocarbons up to C₄₀ has been accomplished by means of a thermal conductivity cell with column temperatures up to 300°C.
5. Dynamically Precise Mixing of Gas Streams for Automatic Gas Analysis.
AGEIKIN, D. I., ITSKOVICH, E. L. and MIKHAILOV, S. P.
Zavodskaya Lab. **23** 492-496 (1957). *Chem. Abstr.* **52** 806 (1958).
An automatic sampler withdraws gas from the line, and after purification it is fed continuously to the gas analyser.
6. Gas Sampling Device for Gas Analysers.
AGEIKIN, D. I., ITSKOVICH, E. L., VOROB'EV, I. N. and MIKHAILOV, S. P.
U.S.S.R. 104,147 (1956). *Chem. Abstr.* **51** 5477 (1957).
No details are given in *Chem. Abstr.*, but it is possible that the device is similar to that described in the previous reference.

7. Hydrogen Labelling of Hydrocarbons Using Ionising Radiations.
AHRENS, R. W., SAUER, M. C. and WILLARD, J. E.
J. Am. Chem. Soc. **79** 3285-3286 (1957). *Chem. Abstr.* **51** 14428 (1957).
Gas chromatography was used to analyse the tritiated products of reaction, and to determine their distribution.
8. Process Control by Analytical Instrumentation.
AIKMAN, A. R.
Chem. Eng. **64** (6) 266-273 (1957). *Chem. Abstr.* **51** 11775 (1957).
No details are given in *Chem. Abstr.* The article describes instruments used in process control, and includes a section on gas chromatographic instrumentation.
9. Chromatography.
ALLEN, R. R.
J. Am. Oil Chemists' Soc. **32** (11) 638-640 (1955). *Chem. Abstr.* **50** 1338 (1956).
No information is given in *Chem. Abstr.* The article describes the techniques of chromatography, and gives a very short general description of the separation of fatty acids by gas chromatography, using titration as detector.
10. A Simple Gas Inlet for Use with Vacuum Systems.
ALMOND, J.
J. Sci. Instr. **35** (2) 70 (1958).
Describes a simple gadget which obviates many inconveniences of other apparatus. It is compact and trouble free.
11. Chromatography Has Become a Valuable Test as a Guide to Fractionator Operation.
ALTON, A. B.
Oil Gas J. **56** (16) 122 (1958). *Chem. Abstr.* **52** 15883 (1958).
The control of fractionating columns by the use of gas chromatographic analysis is discussed.
12. Gas-Liquid Partition Chromatography of Organic Sulphur Compounds.
AMBERG, C. H.
Can. J. Chem. **36** (3) 590-592 (1958). *Chem. Abstr.* **52** 8826 (1958).
The relative elution times of thiols, organic sulphides and alkylthiophens were measured. Columns were of glass containing tricresyl phosphate on firebrick, and nitrogen was used as carrier gas. The eluate was condensed in a liquid nitrogen trap which could be fitted to a mass spectrometer.
13. A Thermal Conductivity Gauge for Use in Gas-Liquid Partition Chromatography.
AMBROSE, D. and COLLERSON, R. R.
J. Sci. Instr. **32** (8) 323 (1955).
The separation of components in gas chromatography depends on the use of a sensitive detector. Thermistors can be used in an easily assembled gauge to give satisfactory results. Full details of its construction and use are given.

14. Use of Gas-Liquid Partition Chromatography as a Preparative Method.
AMBROSE, D. and COLLERSON, R. R.
Nature **177** (4498) 84 (1956). *Chem. Abstr.* **50** 8262 (1956).
One line of approach to the problem of processing large amounts of material would be automatic repetition of the cycle of batch operations. Under fixed column conditions, each substance emerges at a constant time after injection, suggesting that a clock could be used for controlling the cyclic process. Such a clock has been used successfully in the separation of C_4 hydrocarbons. Full details are given.
15. The Presentation of Gas-Liquid Chromatographic Retention Data.
AMBROSE, D., KEULEMANS, A. I. M. and PURNELL, J. H.
Advances in Gas Chromatography—Am. Chem. Soc. Symposium, New York, September 1957. D143-D151. Published by Am. Chem. Soc. 1957.
Methods of presentation of retention volume and partition coefficient data are compared and discussed, the theory of James and Martin being used as a basis of discussion. This theory is summarised. The effect of temperature is also discussed, and recommendations for the presentation of such data are made.
16. Presentation of Gas-Liquid Chromatographic Retention Data.
AMBROSE, D., KEULEMANS, A. I. M. and PURNELL, J. H.
Anal. Chem. **30** (10) 1582 (1958).
Methods for the presentation of retention data are discussed, and it is recommended that this should be expressed either graphically or in tabulated form. Known relationships between elution temperature and either partition coefficient or specific retention volume should be used.
17. The Presentation of Gas-Liquid Chromatographic Retention Data. Part II.
AMBROSE, D. and PURNELL, J. H.
Gas Chromatography 1958. Amsterdam Symposium, May 1958. 369-372. Ed. DESTY, D. H. Published by Butterworths 1958.
The previous reference is considered to be Part I of this article. Recommendations have been made by the Committee of the Gas Chromatography Discussion Group about the presentation of retention data. Tables based on published work are given as examples of these recommendations and the method of compilation is discussed.
18. Utilisation of Gas Chromatography in a Laboratory.
AMENOMIYA, Y.
Kagaku no Ryoiki **12** 577-584 (1958). *Chem. Abstr.* **52** 19338 (1958).
A symposium lecture article. No details are given in *Chem. Abstr.*
19. Podbielniak's Chromacon 9475-3A.
AMENOMIYA, Y.
Kagaku no Ryoiki **12** 606-607 (1958). *Chem. Abstr.* **52** 19339 (1958).
A symposium lecture article. No details are given in *Chem. Abstr.*
20. The Identification and Quantitative Estimation of Gas Chromatography Fractions by Vapour-Phase Infra-red Spectroscopy.
ANDERSON, D. M. W. and DUNCAN, J. L.
Chem. and Ind. (London) 1958 (50) 1662.
Gives some details of the size of 3 gas cells which have been used to increase the sensitivity of i.r. detection on a Hilger H800 spectrometer. More details are promised later.

21. Partition Coefficients from Gas-Liquid Partition Chromatography.
ANDERSON, J. R. A.
J. Am. Chem. Soc. **78** (21) 5692-5693 (1956). *Chem. Abstr.* **51** 1690 (1957).
Heats and entropies of solution may be determined using gas-liquid partition chromatography. Methods are also given for the calculation of the partition coefficient.
22. Vapour-Phase Chromatographic Separation of Aromatics from Saturated and Olefinic Hydrocarbons.
ANDERSON, J. R. A. and NAPIER, K. H.
Australian J. Chem. **9** 541-543 (1956). *Chem. Abstr.* **51** 5717 (1957).
Aromatics can be separated from saturated and olefinic hydrocarbons by gas chromatography using polyether glycols or their derivatives as liquid stationary phases, supported on 44-60 mesh alumina, and nitrogen as carrier gas.
23. Thermodynamic Data from Gas-Liquid Partition Chromatography.
ANDERSON, J. R. A. and NAPIER, K. H.
Australian J. Chem. **10** 250-255 (1957). *Chem. Abstr.* **51** 17329 (1957).
A comparison of partition coefficients obtained in a static system with those obtained from gas-liquid partition chromatography measurements shows agreement. They are thus true equilibrium values. Heats and entropies of solution may be obtained from the temperature dependence of these coefficients.
24. Chromatographic Analysis of Saturated Hydrocarbons C_3-C_7 on Natural Sorbents.
ANDRONIKASHVILI, T. G. and KUZ'MINA, L. P.
Zavodskaya Lab. **22** (12) 1403-1406 (1956). *Chem. Abstr.* **51** 17606 (1957).
Natural adsorbents with a lesser activity than active carbon or silica gel have been used in chromatographic columns at 100-180°C. The compounds tried included natrolite, tripoli, diatomite and kaolin.
25. The Gas Chromatographic Analysis of Chloral.
ANDRYCHUK, D., EDDS, D. L. and KNAPP, R. E.
Presented at the 8th Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, March 1957. Abstract given in Appl. Spectroscopy **11** (2) 102 (1957).
Techniques for handling liquid samples requiring a high precision are presented. Procedures are given for the analysis of chloral and dichloroacetaldehyde.
26. Some Observations on Volatile Fatty Acids in the Sheeps Rumen.
ANNISON, E. F.
Biochem. J. **57** 400-405 (1954). *Chem. Abstr.* **48** 10883 (1954).
The volatile fatty acids from rumen liquors were analysed as their methyl esters by gas-liquid chromatography. The presence of isobutyric, isovaleric and α -methyl butyric acids was demonstrated.
27. Studies on the Volatile Fatty Acids of Sheep Blood with Special Reference to Formic Acid.
ANNISON, E. F.
Biochem. J. **58** 670-680 (1954). *Chem. Abstr.* **49** 4830 (1955).
A complete analysis by gas-liquid chromatography of the volatile fatty acids present in 10-20 ml of blood has shown the presence of formic acid which normally accounts for 10-30% of the volatile fatty acids present.

28. Studies on the Portal Blood of Sheep. II. Absorption of Volatile Fatty Acids from the Rumen of the Sheep.
ANNISON, E. F., HILL, K. J. and LEWIS, D.
Biochem. J. **66** 592-599 (1957). *Chem. Abstr.* **51** 18183 (1957).
Gas-liquid chromatography was used to analyse the volatile fatty acids as described in the previous references.
29. The Metabolism of Short Chain Fatty Acids in the Sheep. III. Formic, *n*-Valeric and Some Branched Chain Acids.
ANNISON, E. F. and PENNINGTON, R. J.
Biochem. J. **57** 685-692 (1954). *Chem. Abstr.* **48** 12993 (1954).
The volatile fatty acids are estimated by gas chromatography. Isobutyric, isovaleric, *n*-valeric and α -methyl butyric acids, which are known to occur in the sheep's rumen, can be absorbed into the blood from the rumen.
30. Gas Chromatography.
ANON.
Perfumery Essent. Oil Record **48** 49 (1947).
A general description of the method of gas chromatography.
31. Symposium on Gas Chromatography at Stevenston, Scotland, May 1955.
ANON.
Anal. Chem. **27** 1667 (1955).
Abstracts of 5 papers presented at a Symposium arranged by the *Soc. for Anal. Chem.* These are listed in their appropriate places. A very much fuller account of the Symposium and the papers presented is given in *Analyst* **81** (958) 52-58 (1956).
32. Vapour-Phase Analysis.
ANON.
Chem. Age (London) **72** (1872) 1196 (1955).
A very short and general description of vapour-phase partition chromatography.
33. Vapour-Phase Chromatography.
ANON.
Chem. Eng. News **33** (15) 1510-1511 (1955).
A short news item giving some advantages and limitations of vapour-phase chromatography.
34. Sorting Molecules.
ANON.
Nature **176** (4495) 1188-1190 (1955).
Gives an account of 3 papers presented at the British Association meeting in Bristol, September 1955. These 3 papers are included in the appropriate places under the names of the authors.
35. Chromatography Instrument.
ANON.
Am. Perfumer Aromat. **67** 57 (May 1956).
A brief description of the Fisher-Gulf Partitioner, and of gas-liquid chromatography. The instrument has a 14 ft column and built-in integrator.

- 36. New Chromatography Instruments Feature Versatility.**
ANON.
Anal. Chem. **28** (10) 76A (1956).
A news item giving a description of apparatus available for use in gas chromatography.
- 37. Gas-Liquid Partition Chromatography Catching on Fast.**
ANON.
Chem. Eng. **63** (6) 116, 118, 120 (1956).
A general description of this new technique, its potentialities and the wide range of its application. It also described methods which are being used to adapt the technique to automatic process control and analysis.
- 38. Urea-Adduct Process Gains Ground in Lubricating Oil Dewaxing.**
ANON.
Chem. Eng. **63** (11) 114 (1956).
A description of the use of urea in Standard Oil's new plant.
- 39. Gas Chromatography Growing.**
ANON.
Chem. Eng. News **34** (15) 1692-1696 (1956).
A description of the history of chromatography and the development of apparatus by various firms in America. The article lists many applications and speculates on the future of the technique in process control. A definition of chromatography is given and the gas chromatographic technique is described.
- 40. Bridge to the Future ?**
ANON.
Chem. Eng. News **34** (49) 5992, 5995 (1956).
A description of the gas density balance, detailing its advantages.
- 41. Separating Fluids by Gas-Liquid Partition Chromatography.**
Chem. Process Eng. **37** (2) 59 (1956).
A short general article on the American application of this British discovery. No details.
- 42. Gas Chromatography.**
ANON.
Oil Gas J. **54** (85) 126-140 (1956).
Seven short unsigned articles based on papers by other authors. These articles are included under the appropriate authors' names.
- 43. British Society of Cosmetic Chemists hears Talk on Gas-Liquid Chromatography.**
ANON.
Am. Perfumer Aromat. **70** 81 (December 1957).
A brief review of a general talk given by A. T. James.
- 44. Continuous Chlorine Analysis.**
ANON.
Anal. Chem. **29** (2) 23A, 26A (1957).
Describes a method for the continuous analysis for chlorine and impurities using helium as carrier gas. A differential pressure regulator holds the

inlet pressure of the helium constant. The column is 8 ft $\times$ $\frac{3}{8}$ in., containing diatomaceous earth coated with 20% by wt of fluorinated hydrocarbon lubricant. At first a thermal conductivity detector was used, but this was later replaced by a glass coated thermistor type cell.

45. Gas Chromatography to 350°C.

ANON.

Anal. Chem. **29** (2) 26A, 28A (1957).

Describes the gas chromatographic technique and methods for temperatures up to 350°C. The column is of borosilicate glass, 2 ft long by 4-9 mm. The partition medium is high vacuum silicone grease or polythene added to diatomaceous earth, the carrier gas helium and detection is by thermal conductivity.

46. Chromatography Reaches the Plant.

ANON.

Chem. Eng. News **35** (33) 77-79 (1957).

A general description of apparatus manufactured by 5 American companies, giving a table comparing features of the plant models produced.

47. Novel Gas Chromatographic Method Finds New Acids in Cigarette Smoke—It may Find other Uses Too.

ANON.

Chem. Eng. News **35** (50) 46 (1957).

A brief news item mentioning the isolation of 10 non-volatile acids from cigarette smoke. The acids were converted quantitatively to their methyl esters with diazomethane before separation on a Perkin-Elmer Vapour Fractometer.

48. Methods of Analysis by Adsorption.

ANON.

Chem. Prods. **20** (9) 379-380 (1957). *Anal. Abstr.* **5** 1083 (1958).

Describes the use of molecular sieves as selective adsorbents, illustrating the description by Linde Type 5A and silica gel.

49. Mass vs Vapour.

ANON.

Chem. Eng. News **35** 70 (1957).

Gives a table comparing the advantages of the mass spectrometer against the gas chromatograph, and includes a discussion citing the major difficulties and rapid development of each.

50. Molecular Sieves.

Chem. Trade J. **140** (3643) 742 (1957).

A short description of Linde Molecular Sieves, Types 4A and 5A.

51. Application of Gas Chromatography to the Study of Essential Oils and their Constituents.

ANON.

Essenze deriv. agrumari **27** (4) 208-218 (1957).

A review with 66 references.

- 52.** Bendix Time of Flight Mass Spectrometer No. 12-100 Coupled to a Gas Chromatographic Unit.

ANON.

Oil Paint and Drug Reporter **172** (3) 7, 47 (1957).

A very brief and general description of the use of the 2 instruments for the separation and identification of volatile materials.

- 53.** Vapour-Phase Chromatography.

ANON.

Perfumery Essent. Oil Record **48** 142 (1957).

A Perkin-Elmer brochure gives details of their Vapour Fractometer, and reviews columns, column performance, trace analysis and the combination of gas chromatography with infra-red.

- 54.** Flame Chromatograph.

ANON.

Perfumery Essent. Oil Record **48** 415 (1957).

A description of the Shandon Scientific Co. apparatus incorporating a flame detector. Their brochure includes chromatograms of lavender oil, limonene and American peppermint oil.

- 55.** Gas Chromatography Widens Range.

ANON.

Chem. Eng. News **36** (11) 59, 63 (1958).

A short description of 3 new instruments:—

(1) The Burrell Corporation's Model K-5 Kromo-Tog can deal with materials boiling up to 475°C, the only limitation being the availability of column packing materials for use at such high temperatures.

(2) The Consolidated Electrodynamics Corporation's Type 26-201A chromatograph contains a pre-cut column and a new rotary valve. Undesired portions of the sample may thus be eliminated.

(3) Reet Instrument's chromatograph incorporates a constant current supply circuit for its thermal conductivity cell.

- 56.** Podbielniak Plant at New York Exhibition.

ANON.

Perfumery Essent. Oil Record **49** 46 (1958).

Among other instruments, the Podbielniak Gas Chromatographs, including their preparative apparatus, are briefly described.

- 57.** Gas Chromatography.

ANON.

Perfumery Essent. Oil Record **49** 56 (1958).

A brochure from Griffin and George describes their instrument and gives traces for the methyl esters of fatty acids, distilled palm kernel fatty acids, American peppermint oil and lavender oil.

- 58.** New Pye Gas-Liquid Chromatography Equipment.

ANON.

Perfumery Essent. Oil Record **49** 270 (1958).

The Pye instrument equipped with a high sensitivity katharometer is described in detail.

- 59.** The Beckman Industrial Gas Chromatograph, Model 220.
ANON.
Process Control and Automation **5** (2) 54-55 (1958).
This instrument is designed specifically for continuous monitoring of industrial gas streams, and incorporates a unique linear sampling valve. The temperature may be controlled to 0.2°C between 40 and 110°C.
- 60.** Use of the Gas-Phase Chromatograph in Solvent Problems.
ANON.
Off. Digest **30** (406) 1172 (1958).
The apparatus has been used to determine the purity of solvents and the degree of mixing, to detect contaminants, and to study differences in similar solvents, drying problems and water-based paints.
- 61.** The Reactions of Gaseous Fluorine and Chlorine with Liquid *n*-Butane and *iso*-Butane.
ANSON, P. C. and TEDDER, J. M.
J. Chem. Soc. 1957 4390-4394. *Chem. Abstr.* **52** 5281 (1958).
The products of reaction were estimated by gas chromatography, using a column of dinonyl phthalate on Celite 545. The carrier gas was 'oxygen-free' nitrogen, and detection was by thermal conductivity.
- 62.** Some Comments on Gas Chromatography Apparatus in the Present Status.
ARAKI, S. and MASHIKO, Y.
Kagaku no Ryoiki **12** 575-576 (1958). *Chem. Abstr.* **52** 19338 (1958).
A Symposium lecture article. No details given in *Chem. Abstr.*
- 63.** Gas Chromatography.
ASAHARA, T. and TAKAGI, Y.
Abura Kagaku **6** 32-36, 108-112 (1957). *Chem. Abstr.* **51** 11810 (1957).
A review with 63 references.
- 64.** The Use of Adsorption for Isolation of Aromatic Substances.
ASATOOR, A. and DALGLIESH, C. E.
J. Chem. Soc. 1958 1498-1501. *Chem. Abstr.* **52** 10686 (1958).
Charcoal is partially de-activated by treatment with either stearic acid or octadecylamine, and is then used to study the competitive adsorption effects of mixtures of adsorbents. A good recovery of the minor components of mixtures can be achieved if a sufficient quantity of adsorbent is used.
- 65.** Analysis of Terpenes by Gas Chromatography and Spectroscopy. (U.V. and I.R.)
ASCOLI, F. and CRESCENZI, V.
Chim. e ind. (Milan) **40** 724 (1958).
The products of reaction of linalol with acetic anhydride are examined and 3 terpenes are found, 2 of which are identified by their retention time on tricresyl phosphate at 132°C. Relative retention times for various terpenes are reported.
- 66.** A Versatile Gas-Liquid Partition Chromatography Apparatus Developed for Analytical Use.
ASHBURY, G. K., DAVIES, A. J. and DRINKWATER, J. W.
Presented at the 129th National A.C.S. Meeting, Dallas, Texas. April 1956. Abstracts 16B No. 43.
Description of an apparatus developed in an attempt to remove instrumental limitations of the technique, and to allow future modifications to

be incorporated as easily as possible. Columns may be rapidly interchanged and temperatures varied at will. A thermal conductivity detector of refractory material permits the use of temperatures over 300°C.

67. Versatile Gas-Liquid Partition Chromatography Apparatus.

ASHBURY, G. K., DAVIES, A. J. and DRINKWATER, J. W.

Anal. Chem. **29** (6) 918-925 (1957). *Chem. Abstr.* **51** 12567 (1957).

The apparatus was designed to allow future modifications to be added as easily as possible. The recorder unit can be connected as required to any one of several column-furnace units. A hot wire thermal conductivity detector constructed entirely from refractory materials allowed reliable operation at temperatures of over 300°C.

68. Applications of Chromatography to Fatty Acids.

ASSELINÉAU, J.

Chim. anal. **39** (10) 375-383 (1957). *Chem. Abstr.* **52** 4415 (1958).

The application of gas-phase chromatography to the separation and identification of fatty acids is reviewed. 115 references are appended.

69. An Automatic 'Preparative-Scale' Gas Chromatography Apparatus.

ATKINSON, E. P. and TUEY, G. A. P.

Gas Chromatography 1958. *Amsterdam Symposium, May 1958.* 270-283. *Ed. DESTY, D. H. Published by Butterworths* 1958. *Discussion* 283-287.

Considerations which control the design of a preparative scale apparatus are discussed. A 1 gm injection is thought to be the most convenient, and larger quantities can be dealt with by the repetition of operations. Completely automatic control of the whole cycle is possible.

70. The Photolysis of 2-Pentanone and 2-Pentanone-1,1,1,3,3,-d₅.

AUSLOOS, P. and MURAD, E.

J. Am. Chem. Soc. **80** (22) 5929-5932 (1958). *Chem. Abstr.* **53** 6998 (1959).

Gas chromatography is used to separate hexane, acetone, biacetyl and the parent compound. The separation of hexane and acetone is accomplished on a 1 m column of polyethylene glycol in series with a 1 m column of polyoxyethylene sorbitan monostearate. No further details are given.

71. Chromatographic Analysers in Process Instrumentation.

AYERS, B. O.

Gas Chromatography. Instr. Soc. Am. Symposium, August 1957.

Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 249.

A description and discussion of the required performance standards and design specifications for process analysers, stressing the operations which the apparatus must perform automatically. Some applications are described.

72. Chromatographic Analysis of Trace Quantities of Carbon Monoxide in Ethylene.

AYERS, B. O., LOYD, R. J. and REINECKE, M. E.

Presented at the Pittsburgh Conference on Anal. Chem., March 1958. Paper 18.

No further details are available.

- 73. Separation of Mixtures of Simplest Hydrocarbons by the Method of Chromathermography.**
AYVAZOV, B. V. and VYAKHIREV, D. A.
Zhur. Priklad. Khim. **26** 505-511 (1953). *Chem. Abstr.* **48** 6371 (1954).
A column of silica gel was used to separate C_2H_6 , C_2H_4 , C_3H_8 , C_3H_6 and 1-butene, dry air being the desorbing medium.
- 74. Apparatus for Gas Analysis by Thermal Conductivity.**
BADRE, F. R. G. and GUILLERM, R. G.
Fr. Patent 1,134,776 (1957). *Chem. Abstr.* **51** 8489 (1957).
No details are given in *Chem. Abstr.*
- 75. Design Parameters for Process Gas Chromatographs.**
BAKER, W. J., NORLIN, H. L., ZINN, T. L. and WALL, R. F.
Advances in Gas Chromatography. Am. Chem. Soc. Symposium, New York, September 1957.
Published by Am. Chem. Soc. 1957. D-43 to D-49.
Various types of thermal conductivity detector are described (thermistor, etc.), and differences in positioning of thermistors are shown in a table. The effect of column to detector path and of column diameter are also discussed.
- 76. Some Applications of Vapour-Phase Chromatography.**
BAREFOOT, R. R. and CURRAH, J. E.
Presented at 38th Ann. Conf. Chem. Institute of Canada, Quebec, May 1955.
An abstract is given in *Chem. in Canada* **7** (5) 53 (1955).
A general description of vapour-phase chromatography, giving its advantages. 2 examples of its application are given:—
(1) Separation of chlorinated methanes, ethanes and ethylenes, and
(2) Determination of benzene in toluene. See next abstract.
- 77. Some Applications of Vapour-Phase Chromatography.**
BAREFOOT, R. R. and CURRAH, J. E.
Chem. in Canada **7** (11) 45-48, 50, 52 (1955). *Chem. Abstr.* **50** 3143 (1956).
A general description of the technique, giving its advantages. An apparatus is described using nitrogen as carrier gas and thermal conductivity detection. Examples are given of the separation of chloroethanes, chloro-methanes, and chloroethylenes on paraffin oil, and the determination of benzene in toluene using acetone as internal standard.
- 78. Gas Chromatography. Review of Recent Progress.**
BAREFOOT, R. R. and CURRAH, J. E.
Chem. in Canada **9** (3) 68-72 (1957). *Chem. Abstr.* **51** 7802 (1957).
A review with 36 references.
- 79. Gas-Phase Mass Transfer in Fixed Beds at Low Reynolds Numbers.**
BAR-ILAN, M. and RESNICK, W.
Ind. Eng. Chem. **49** (2) 313-320 (1957). *Chem. Abstr.* **51** 7068 (1957).
A review of previous studies on mass transfer in packed beds, and a description of an investigation into this subject which substantially confirmed previously reported results.

80. The Pyrolysis of *n*-Butanol.

BARNARD, J. A.

Trans. Faraday Soc. **53** (11) 1423-1430 (1957). *Chem. Abstr.* **52** 12528 (1958).

Vapour-phase chromatography was used for a semi-quantitative analysis of the condensable products of the reaction. Ethane, ethylene, propane and propylene were separated on a column consisting of tri-*isobutylene* on Celite.

81. The Sorption of Polar and Non-polar Gases by Zeolites.

BARRER, R. M.

Proc. Roy. Soc. (London) **A 167** 393-420 (1938). *Chem. Abstr.* **33** 4104 (1939).

Zeolites consisting of 3-dimensional networks (e.g. chabazite and analcite), can adsorb enormous quantities of argon, hydrogen, nitrogen and helium in the temperature range 62-384°K.

82. A Process for the Fractionation of Hydrocarbon Mixtures.

BARRER, R. M.

B.P. 548,905 (1942). *Chem. Abstr.* **38** 374 (1944).

Describes the use of zeolites as molecular sieves.

83. Fractionation of Mixtures of Hydrocarbons.

BARRER, R. M.

U.S. 2,306,610 (1942). *Chem. Abstr.* **37** 3103 (1943).

Describes a process for the separation of straight chain hydrocarbons from branched chain and/or cyclic hydrocarbons by means of natural or synthetic analcite in which some or all of the sodium is replaced by calcium, or by means of chabazite.

84. Zeolites as Adsorbents and Molecular Sieves.

BARRER, R. M.

Ann. Repts. Progr. Chem. **41** 31-46 (1944). *Chem. Abstr.* **42** 8573 (1948).

A review.

85. Separation of Mixtures using Zeolites as Molecular Sieves. Part I. Three Classes of Molecular Sieve Zeolite.

BARRER, R. M.

J. Soc. Chem. Ind. **64** 130-131 (1945). *Chem. Abstr.* **39** 4789 (1945).

Whether or not any molecule can be occluded by a zeolite is determined by molecular size and shape factors of the molecule. Some zeolites exhibit a unique selectivity in sorption, and reasons for this are given. Examples of occlusion and exclusion by zeolites are given, the zeolites being divided into 3 broad classes.

86. Separation of Mixtures Using Zeolites as Molecular Sieves. Part III. The Use of Zeolites to Separate Polar Molecules from Mixtures Containing Them.

BARRER, R. M.

J. Soc. Chem. Ind. **64** 133-134 (1945). *Chem. Abstr.* **39** 4790 (1945).

Zeolites were used to effect specific separations. Components of mixtures having very similar boiling points could be separated, as could some azeotropic mixtures. The scope of such a separation method is discussed.

87. Improvements in and Relating to the Manufacture of Molecular Sieve Absorbents.
BARRER, R. M.
B.P. 574,911 (1946). *Chem. Abstr.* **43** 1618 (1949).
Describes a process for the manufacture of a synthetic zeolite of the chabazite class.
88. Process for the Manufacture of Crystalline Absorbents.
BARRER, R. M.
U.S. 2,413,134 (1946). *Chem. Abstr.* **41** 1402 (1947).
Describes a hydrothermal method using concentrated aqueous barium salt solutions for the preparation of crystalline molecular sieve absorbents.
89. A Process for the Separation of Mixtures.
BARRER, R. M.
B.P. 600,453 (1948).
Describes the use of molecular sieves.
90. Improvements in and Relating to the Manufacture of Molecular Sieve Absorbents.
BARRER, R. M.
B.P. 600,465 (1948).
The manufacture of molecular sieves is described.
91. Synthesis of a Zeolitic Mineral with Chabazite-like Sorptive Properties.
BARRER, R. M.
J. Chem. Soc. 1948 127-132. *Chem. Abstr.* **42** 4423 (1948).
By heating synthetic and natural analcites with water and excess of barium chloride, potassium chloride or potassium bromide, it was found possible under certain conditions to produce new aluminosilicates as characteristic crystals.
92. Synthesis and Reactions of Mordenite.
BARRER, R. M.
J. Chem Soc. 1948 2158-2163. *Chem. Abstr.* **43** 5323 (1949).
Sodium aluminate is dissolved in water and poured into a suspension of silicic acid gel containing a trace of entrained alkali. The mixture is evaporated to dryness at temperatures of from 70-110°C (definitely not over 110°C), and the product autoclaved with water at 265-295°C. The pH is as important as the composition or temperature in ensuring a yield, and best results were obtained for a pH range of 8-10 in the cold mother liquor after crystallisation.
93. Separations Using Zeolitic Materials.
BARRER, R. M.
Discussions Faraday Soc. 1949 No. 7 135-141. *Chem. Abstr.* **45** 18 (1951).
A short account is given of zeolitic sorptions which are important in separating molecular mixtures. Some natural crystalline zeolites fall into 3 classes of molecular sieve sorbent, each capable of separating mixtures by selective occlusion if the differences in shape and dimensions between the molecules in the mixtures allow. Quantitative separations are possible.

94. Transient Flow of Gases in Sorbents Providing Uniform Capillary Networks of Molecular Dimensions.

BARRER, R. M.

Trans. Faraday Soc. **45** 358-373 (1949). *Chem. Abstr.* **43** 6488 (1949).

Some new molecular sieve sorbents are described which have potential uses in separating the inert gases from one another or from atmospheric gases.

95. Aspects of Intra-Crystalline Sorption.

BARRER, R. M.

J. chim. phys. **47** 82-94 (1950). *Chem. Abstr.* **44** 6701 (1950).

A summary is given of several aspects of the sorption of gases in silicate and ionic crystals. Ion exchange, among other factors discussed, has a profound effect upon the kinetics and energetics of sorption and upon the molecular sieve action shown.

96. The Separation of Molecules with the Aid of Crystal Sieves.

BARRER, R. M.

Brennstoff-Chem. **35** (21/22) 325-334 (1954). *Chem. Abstr.* **49** 3617 (1955).

A long summary of work previously carried out by the author on molecular sieves. 23 references are appended.

97. Stoichiometry of Inclusion Compounds.

BARRER, R. M.

Nature **176** (4485) 745-746 (1955). *Chem. Abstr.* **50** 3840 (1956).

A study of the formation of a variety of inclusion compounds by potassium benzene sulphonate.

98. Separation of Molecular Mixtures Using Crystal Sieves.

BARRER, R. M.

Presented at Brit. Assn. Meeting (Section B), Bristol, September 1955. Reported in Nature **176** 1188-1190 (1955).

A description, with illustrations, of the action of some crystal sieves.

99. Separation of Molecular Mixtures Using Crystal Sieves.

BARRER, R. M.

Presented at Meeting of the Fine Chemicals Group of Soc. Chem. Ind. London, January 1958. Reported in Chem. and Ind. 1958 (9) 252.

A description of work carried out by the author on the discovery, characterisation and application of molecular sieves. Many illustrations of the way in which these crystal sieves work were included.

100. The Hydrothermal Chemistry of the Silicates. VII. Synthetic Potassium Aluminosilicates.

BARRER, R. M. and BAYNHAM, J. W.

J. Chem. Soc. 1956 2882-2891. *Chem. Abstr.* **50** 16506 (1956).

In an attempt to prepare zeolites and other mineral species containing potassium as the only interstitial cation, a series of potassium aluminosilicate gels was prepared and subjected to hydrothermal crystallisation. The effect of temperature and time of crystallisation on the products, and the behaviour of the latter in ion exchange and sorption experiments have been studied.

- 101.** Synthetic Chabazites: Correlation Between Isomorphous Replacements, Stability and Sorption Capacity.
BARRER, R. M. and BAYNHAM, J. W.
J. Chem. Soc. 1956 2892-2903. *Chem. Abstr.* **51** 7099 (1957).
A study has been made of the influence of isomorphous replacements and of ion exchange upon the capacity to occlude water, oxygen and argon.
- 102.** Hydrothermal Chemistry of Silicates. V. Compounds Structurally Related to Analcite.
BARRER, R. M., BAYNHAM, J. W. and McCALLUM, N.
J. Chem. Soc. 1953 4035-4041. *Chem. Abstr.* **48** 4348 (1954).
Sodium, potassium, thorium and caesium aluminosilicates based on an analcite structure can be synthesised directly from gels, and lithium, ammonium, silver and lead hydroxy-forms can be made indirectly.
- 103.** Separation of Mixtures Using Zeolites as Molecular Sieves. Part II. The Use of a Zeolite to Resolve Hydrocarbon Mixtures.
BARRER, R. M. and BELCHETZ, L.
J. Soc. Chem. Ind. **64** 131-132 (1945). *Chem. Abstr.* **39** 4790 (1945).
Chabazite has been used to separate gaseous and liquid hydrocarbons. Ethane may be separated from higher paraffin and cyclic hydrocarbons at room temperature or below. Quantitative separations of *n*-paraffins from mixtures with *iso*-paraffins and aromatic hydrocarbons could be effected at higher temperatures. The limitations of the molecular sieve method are discussed.
- 104.** Sorption and Reactivity of Simple Organic Molecules in Chabazite.
BARRER, R. M. and BROOK, D. W.
Trans. Faraday Soc. **49** 940-948 (1953). *Chem. Abstr.* **48** 5596 (1954).
A study has been made of the sorption, reactivity and molecular sieve behaviour of some organic molecules in chabazite. The following were excluded from crystals by a total molecular sieve action: —CF_4 , CF_2Cl_2 , CF_3Cl , CCl_2FH , CHCl_3 , $\text{N}(\text{CH}_3)_3$, $(\text{CH}_3)_3\text{CCl}$, $(\text{CH}_3)_2\text{CHCl}$, but those given below were occluded in large amounts: —CHF_3 , CClF_2H , CH_3Cl , CH_2Cl_2 , CH_3NH_2 and $(\text{CH}_3)_2\text{NH}$.
- 105.** Molecular Diffusion in Chabazite, Mordenite and Levynite.
BARRER, R. M. and BROOK, D. W.
Trans. Faraday Soc. **49** (9) 1049-1059 (1953). *Chem. Abstr.* **48** 5597 (1954).
The kinetics of sorption have been studied for various gases in zeolites, and values obtained for the mean diffusion coefficients of C_3H_8 , $n\text{—C}_4\text{H}_{10}$, CH_2Cl_2 and $(\text{CH}_3)_2\text{NH}$ at several temperatures in chabazite.
- 106.** Structure of Faujasite and Properties of its Inclusion Complexes with Hydrocarbons.
BARRER, R. M., BULTITUDE, F. W. and SUTHERLAND, J. W.
Trans. Faraday Soc. **53** (8) 1111-1123 (1957). *Chem. Abstr.* **52** 8667 (1958).
An account is given of the channel system in faujasite and of the occlusion within it of benzene, toluene, etc., over a range of temperatures and pressures.
- 107.** Ion Exchange on Synthetic Faujasite.
BARRER, R. M., BUSER, W. and GRUTTER, W. F.
Chimia. **9** (5) 118 (1955).
Cations of this compound are easily exchanged for others. Thus sodium may be replaced by potassium, silver, thorium, ammonium, etc.

108. Ion Exchange in Felspathoids as a Solid-State Reaction.

BARRER, R. M. and FALCONER, J. D.

Proc. Roy. Soc. (London) A **236** (1205) 227-249 (1956). *Chem. Abstr.* **50** 15171 (1956).

Describes a quantitative investigation of ion exchange diffusion and equilibrium in felspathoids.

109. Gas Chromatography and Mixture Isotherms in Alkyl Ammonium Bentonites.

BARRER, R. M. and HAMPTON, M. G.

Trans. Faraday Soc. **53** (11) 1462-1475 (1957). *Chem. Abstr.* **52** 12511 (1958).

Experiments on the sorption of oxygen plus argon and nitrogen plus argon are described, and alkyl ammonium clays are examined as gas chromatographic separation media.

110. Ion Exchange in Crystals of Analcite and Leucite.

BARRER, R. M. and HINDS, L.

J. Chem. Soc. 1953 1879-1888. *Chem. Abstr.* **47** 10308 (1953).

Exchange reactions were investigated quantitatively at low temperatures for the ion-pairs Na-K, Na-Tl, Na-Rb, K-Tl, Tl-Rb and Na-Ag.

111. The Hydrothermal Chemistry of Silicates. Part III. Reactions of Analcite and Leucite.

BARRER, R. M., HINDS, L. and WHITE, E. A. D.

J. Chem. Soc. 1953 1466-1475. *Chem. Abstr.* **47** 8571 (1953).

Analcite is readily synthesised and is used as the starting material for the preparation of other minerals.

112. Occlusion of Hydrocarbons by Chabazite and Analcite.

BARRER, R. M. and IBBITSON, D. A.

Trans. Faraday Soc. **40** (5) 195-206 (1944). *Chem. Abstr.* **38** 5445 (1944).

The occlusion of hydrocarbons up to isooctane was studied. *n*-Hydrocarbons were occluded copiously, but branched chain hydrocarbons were totally excluded.

113. Kinetics of Formation of Zeolitic Solid Solutions.

BARRER, R. M. and IBBITSON, D. A.

Trans. Faraday Soc. **40** (5) 206-216 (1944). *Chem. Abstr.* **38** 5451 (1944).

Solutes are occluded in the lattices of dehydrated chabazite or active analcite at rates which are a function of their cross sectional diameter. Those up to 4.0 Å in cross section diameter are taken up by a process similar to free diffusion, those equal to 4.89 Å (*n*-paraffins) by a slow diffusion process, and those equal to or over 5.58 Å are totally excluded.

114. Hydrothermal Chemistry of Silicates. Part IV. Rubidium and Caesium Aluminosilicates.

BARRER, R. M. and McCALLUM, N.

J. Chem. Soc. 1953 4029-4035. *Chem. Abstr.* **48** 4348 (1954).

Hydrothermal crystallisation of rubidium aluminosilicate gels in the temperature range 160-450°C has yielded several new mineral type species.

- 115. Sorption by Attapulgite. I. Availability of Intracrystalline Channels.**
BARRER, R. M. and MACKENZIE, N.

J. Phys. Chem. **58** (7) 560-568 (1954). *Chem. Abstr.* **48** 11870 (1954).

The kinetics and equilibria of sorption of nitrogen, oxygen, carbon dioxide, water, ammonia, methanol and ethanol on attapulgite indicate some lattice penetration in addition to substantial surface sorption by water and ammonia, but in the other species sorption is confined to the external surfaces.

- 116. Sorption by Attapulgite. II. Selectivity Shown by Attapulgite, Sepiolite and Montmorillonite for *n*-Paraffins.**

BARRER, R. M., MACKENZIE, N. and MacLEOD, D. M.

J. Phys. Chem. **58** (7) 568-572 (1954). *Chem. Abstr.* **48** 11871 (1954).

The sorption of *n*-heptane, isooctane, *n*-, *iso*- and *neopentane* on attapulgite has been studied. Also of the pentanes on montmorillonite and sepiolite. The selectivities are given and discussed.

- 117. Activation of Montmorillonite by Ion Exchange and Sorption Complexes of Tetra-Alkyl Ammonium Montmorillonites.**

BARRER, R. M. and MacLEOD, D. M.

Trans. Faraday Soc. **51** (9) 1290-1300 (1955). *Chem. Abstr.* **50** 4582 (1956).

Replacement of the inorganic cations in montmorillonite by $N(CH_3)_4$ and $N(C_2H_5)_4$ opens up the lamellae and causes profound changes in the sorption and intercalation of organic molecules. Paraffins and aromatic hydrocarbons now become freely sorbed and the sorptive capacity very much increased.

- 118. Structural and Ion Sieve Properties of a Synthetic Crystalline Exchanger.**

BARRER, R. M. and MEIER, W. M.

Trans. Faraday Soc. **54** (7) 1074-1085 (1958).

A description of the properties of Linde molecular sieve A.

- 119. Ion Exchange in Ultramarine.**

BARRER, R. M. and RAITT, J. S.

J. Chem. Soc. 1954 4641-4651. *Chem. Abstr.* **49** 3614 (1955).

Ultramarine is a feldspathoid. Ions which exchange fairly readily include Na, K, Li, Tl, Pb, Zn and Cd. Ions which do not include Ca, Ba, Sr, Mg, NH_4 , Rb and Cs.

- 120. Sorption and Intercalation by Methyl-Ammonium Montmorillonites.**

BARRER, R. M. and REAY, J. S. S.

Trans. Faraday Soc. **53** (9) 1253-1261 (1957). *Chem. Abstr.* **52** 9711 (1958).

Sorption on montmorillonites has been studied for oxygen, nitrogen, argon, methane, *n*- and *isobutane*, benzene, toluene, water, etc.

- 121. Interlamellar Sorption by Montmorillonite.**

BARRER, R. M. and REAY, J. S. S.

Proc. Intern. Congr. Surface Activity 2nd, London, 1957 **2** 79-89. *Chem. Abstr.* **52** 17888 (1958).

The sorptive properties of various types of clay are reviewed, and variations in these properties are correlated with the polarity, shape and size of the adsorbate, and with characteristics of the adsorbent.

122. Sorption by NH_4^+ and Cs^+ Montmorillonites, and Ion Fixation.

BARRER, R. M. and REAY, J. S. S.

J. Chem. Soc. 1958 3824-3830. *Chem. Abstr.* **53** 2733 (1959).

The sorptive capacities of these compounds for nitrogen, oxygen, argon, methane, benzene and water are related to their intersheet spacings.

123. Sorption of Mixtures. Part III. Polar Sorbates as Modifiers of Zeolitic Crystals.

BARRER, R. M. and REES, L. V.

Trans. Faraday Soc. **50** (8) 852-863 (1954). *Chem. Abstr.* **49** 2812 (1955).

Systematic additions of polar molecules (ammonia, water or methylamine) to mordenite and chabazite, have a profound effect on the subsequent occlusion of non-polar gases (hydrogen, oxygen, nitrogen, argon and ethane).

124. Sorption of Mixtures. Part IV. Molecular Diffusion in Crystals Modified by Polar Sorbates.

BARRER, R. M. and REES, L. V.

Trans. Faraday Soc. **50** (9) 989-999 (1954). *Chem. Abstr.* **49** 4365 (1955).

The diffusion of hydrogen, oxygen, nitrogen, argon and ethane has been studied in crystals of chabazite and of mordenite modified by progressive additions of water, ammonia and methylamine.

125. Sorptive and Molecular Sieve Properties of a New Zeolitic Mineral.

BARRER, R. M. and RILEY, D. W.

J. Chem. Soc. 1948 133-143. *Chem. Abstr.* **42** 4423 (1948).

The new mineral was used in an investigation of sorption phenomena involving helium, neon, argon, krypton, oxygen, nitrogen, ammonia and hydrocarbons. It behaved as a molecular sieve in the same way as chabazite.

126. Sorption of Mixtures. I. Molecular Sieve Separations of Permanent and Inert Gases.

BARRER, R. M. and ROBINS, A. B.

Trans. Faraday Soc. **49** (7) 807-815 (1953). *Chem. Abstr.* **48** 3099 (1954).

Because of the fact that the rates of occlusion of gases such as hydrogen, neon, oxygen, nitrogen, argon and krypton in crystals of outgassed synthetic mordenite differ substantially among themselves, it was found that some mixtures could be separated. These included argon/nitrogen, argon/oxygen, neon/hydrogen, argon/neon, and argon/hydrogen. It was however found that argon/krypton could not be separated by this method. The separation of the mixtures could also be altered by the addition of small amounts of water to the zeolite, often improving the separation.

127. Sorption of Mixtures. Part II. Equilibria Between Binary Gas Mixtures and Some Zeolites.

BARRER, R. M. and ROBINS, A. B.

Trans. Faraday Soc. **49** 929-939 (1953). *Chem. Abstr.* **48** 5597 (1954).

The sorption of hydrogen, neon, oxygen and nitrogen in mordenite, and of oxygen, argon and nitrogen in chabazite has been studied at -183°C for the pure gases, and for mixtures of hydrogen/neon, hydrogen/nitrogen, neon/oxygen (on mordenite), and argon/oxygen, argon/nitrogen (on chabazite).

- 128. Exchange Equilibria in Crystals of Chabazite.**
BARRER, R. M. and SAMMON, D. C.
J. Chem. Soc. 1955 2838-2849. *Chem. Abstr.* **49** 15439 (1955).
Exchange equilibria between aqueous solutions and crystals of chabazite were studied for the following ion pairs: —Na-Cu, Na-Ag, Na-Tl, Na-Rb, Na-Ca, Na-Ba and K-Ag.
- 129. An Ion-Sieve Reagent for Caesium-Alkali-Metal Separations.**
BARRER, R. M. and SAMMON, D. C.
J. Chem. Soc. 1956 675-682. *Chem. Abstr.* **50** 8366 (1956).
Describes an investigation into the use of Ag-analcite as an ion-sieve reagent for separations of caesium from other alkali metals.
- 130. Sorption and Surface Diffusion in Microporous Carbon Cylinders.**
BARRER, R. M. and STRACHAN, E.
Proc. Roy. Soc. (London) A **231** (1184) 52-74 (1955). *Chem. Abstr.* **49** 14419 (1955).
The carbon cylinders used were compressed to different porosities, and the adsorption and diffusion of helium, neon, hydrogen, argon, nitrogen and krypton through them was investigated.
- 131. Inclusion Complexes of Faujasite with Paraffins and Permanent Gases.**
BARRER, R. M. and SUTHERLAND, J. W.
Proc. Roy. Soc. (London) A **237** 439-463 (1956). *Chem. Abstr.* **51** 15214 (1957).
The occlusion of oxygen, argon, nitrogen and methane within the crystal lattice of faujasite was investigated.
- 132. The Hydrothermal Chemistry of Silicates. Part I. Synthetic Lithium Aluminosilicates.**
BARRER, R. M. and WHITE, E. A. D.
J. Chem. Soc. 1951 1267-1278. *Chem. Abstr.* **45** 7460 (1951).
The preparation and formation of these silicates over the temperature range 150-450°C was studied.
- 133. The Hydrothermal Chemistry of Silicates. Part II. Synthetic Crystalline Sodium Aluminosilicates.**
BARRER, R. M. and WHITE, E. A. D.
J. Chem. Soc. 1952 1561-1571. *Chem. Abstr.* **46** 9007 (1952).
The hydrothermal reactions of sodium aluminosilicate were investigated between 150 and 450°C, and the crystal growth examined both in the presence and absence of additional sodium compounds.
- 134. Separation of Derivatives of Amino Acids Using Gas-Liquid Chromatography.**
BAYER, E.
Gas Chromatography 1958. *Amsterdam Symposium, May 1958.*
Ed. DESTY, D. H. Published by Butterworths 1958. 333-339. *Discussion* 339-342.
Amino acids are separated in the form of their methyl esters on a stationary phase of silicone grease containing 10% of sodium caproate which reduces 'tailing'. This material also enables isomers like norvaline and valine or norleucine and leucine to be distinguished. The paper also described a katharometer having a low noise level and an air thermostat.

- 135.** The Application of Gas Chromatography to the Analysis of Synthetic and Natural Aromatic Compounds.

BAYER, E., KUPFER, G. and REUTHER, K. H.

Presented at Meeting on 'The Analysis of Gaseous and Liquid Hydrocarbons and their Derivatives by Physical Methods'. Essen, January 1958. Printed in Z. anal. Chem. **164** (1) 1-9 (1958).

In German. 15 substances were separated from geranium oil and 8 were identified by measurements of retention volumes on various stationary phases at varying temperatures.

- 136.** Analysis of Amino Acid Mixtures by Gas Partition Chromatography.

BAYER, E., REUTHER, K. H. and BORN, F.

Angew. chem. **69** (20) 640 (1957). *Anal. Abstr.* **5** 2335 (1958).

The amino acids are converted to their methyl esters by reaction with hydrochloric acid in methanol, and the esters are liberated by sodium hydroxide, extracted with ether and separated by gas chromatography on a column of silicone high vacuum oil plus 10% sodium caproate supported on Sterchamol. Hydrogen is used as carrier gas, and detection is by thermal conductivity.

- 137.** On the Theory of Adsorption Chromatography for Liquid Mixtures.

BAYLE, G. G. and KLINKENBERG, A.

Rec. trav. chim. **73** (11) 1037-1057 (1954). *Chem. Abstr.* **49** 12082 (1955).

A critical review of the theory of adsorption chromatography. The shape of the chromatogram obtained depends on the characteristics of the governing adsorption isotherms, and it is shown that both the discontinuous and continuous shapes are consistent with the equilibrium theory.

- 138.** Steric Effects in the Gas-Liquid Chromatography of some Alkylbiphenyls.

BEAVEN, G. H., JAMES, A. T. and JOHNSON, E. A.

Nature **179** (4557) 490-491 (1957). *Chem. Abstr.* **51** 11003 (1957).

The retention volumes are given for about 30 compounds. The stationary phase was Apiezon M which behaves as a largely non-polar material, although it is somewhat more polar than, e.g. paraffin wax. The column temperature was 197°C.

- 139.** Reaction of Chlorobenzene with Methyl Radicals.

BECKWITH, A. L. J. and WATERS, W. A.

J. Chem. Soc. 1957 1665-1668. *Chem. Abstr.* **51** 13822 (1957).

The presence of chlorotoluenes in the reaction products was detected using vapour-phase chromatography on a column of dinonyl phthalate on Celite at 130°C. The column was operated under reduced pressure.

- 140.** A Study of Silver Nitrate Solutions in Gas Chromatography.

BEDNAS, M. E. and RUSSELL, D. S.

Can. J. Chem. **36** 1272-1276 (1958). *Chem. Abstr.* **53** 1979 (1959).

Silver nitrate dissolved in some organic solvents has formed a relatively specific medium for the gas chromatographic separation of olefins. Columns of ethylene glycol or glycerin solutions of silver nitrate are comparable, but those of polyethylene glycol solutions are considerably less effective. Such silver nitrate solutions are stable below 65°C, but begin to decompose slowly at 85°C.

141. Gas Chromatography.

BEERTHUIS, R. K.

Chem. Weekblad. **53** 545-547 (1957).

In Dutch with an English summary. The principles of gas chromatography are reviewed with particular reference to research on lipids, and examples are given of the analysis of the higher fatty acids in rapeseed oils (up to C_{22}), ground nut oil (up to C_{24}) and *Ximenia caffra* oil (up to C_{26}).

142. Gas Chromatographic Analysis of Higher Fatty Acids: Up to and Including Cerotic Acid.

BEERTHUIS, R. K. and KEPPLER, J. G.

Nature **179** (4562) 731-732 (1957). *Chem. Abstr.* **51** 10313 (1957).

The analysis is accomplished using a column packed with Celite 545 plus either Apiezon L, Dow Corning silicone oil, Edwards silicone grease, or with Alkathene grade 2. The temperature of operation was 257°C, the carrier gas nitrogen, and detection was by means of a gas density meter.

143. Analysis of Biological Gas Mixtures.

BEHMANN, F. W. and KERCKOFF, W. G.

Arch. tech. Messen Lfg. **263** 271-274 (1957). *Chem. Abstr.* **52** 7936 (1958).

A review giving descriptions of analyses by thermal conductivity and other methods. 73 references.

144. Filling of Adsorption Tubes (For Chromatography).

BEKESY, M.

Z. Anal. Chem. **157** (4) 272-274 (1957). *Chem. Abstr.* **52** 1689 (1958).

A method for filling chromatographic columns and removing the separate sections is described.

145. Application of Vapour Chromatography to Infra-red Spectroscopy of Liquids.

BELLIS, H. E. and SLOWINSKI, E. J.

J. Chem Phys. **25** (4) 794 (1956). *Chem. Abstr.* **51** 1733 (1957).

One possible application of gas chromatography lies in its furnishing pure organic compounds for use as reference standards in i.r. studies. A procedure has recently been evolved which allows one to obtain on a routine basis the i.r. spectra of chromatographically pure liquids from samples having an initial volume of less than 0.03 ml.

146. The Influence of Silica Gel Surface Dehydration on the Adsorption of Benzene and Hexane Vapours.

BELYAKOVA, L. D. and KISELEV, A. V.

Doklady Akad. Nauk. S.S.S.R. **119** (2) 298-301 (1958). *Chem. Abstr.* **52** 19337 (1958).

Silica gel dehydrated at 200-900°C in vacuo for varying times did not vary in structure, but its hydration varied, and the amount of benzene and hexane adsorbed was a function of the surface hydroxyl concentration.

147. Recovery of Pure Acetylene from Gas Mixtures of Low Acetylene content by Continuous Gas Chromatography.

BENEDEK, P. and SZEPESY, L.

Erdol u Kohle **9** 593-597 (1956). *Chem. Abstr.* **51** 1506 (1957).

Using activated charcoal in a process in which the charcoal moves downwards through a reactor, pure acetylene may be isolated from the products of the partial oxidation of natural gas. The mixed gases are fed in at the middle of the column and the acetylene is recovered from the bottom zone.

148. Continuous Gas Chromatography. II. Dynamic Adsorption on Fixed and Moving Carbon Beds.

BENEDEK, P. and SZEPESEY, L.

Acta Chim. Acad. Sci. Hung. **14** (1/2) 19-29 (1958). *Anal. Abstr.* **6** 202 (1959).

It has been found that optimum performance is obtained when the velocity of the carbon is equal to the advancing velocity of the gas. It has also been found that the presence of carbon dioxide exerts no marked effect on acetylene adsorption, but that adsorption is decreased if moisture is present in the carbon.

149. Continuous Gas Chromatography. III. Adsorption Equilibria of Acetylene-Carbon Dioxide Mixtures.

BENEDEK, P. and SZEPESEY, L.

Acta Chim. Acad. Sci. Hung. **14** (1/2) 31-41 (1958). *Anal. Abstr.* **6** 202 (1959).

In English. The adsorption of acetylene-carbon dioxide mixtures on activated carbon (Nuxit A) was studied at 20, 50 and 90°C. The adsorption of components from the mixture was lower than that of the pure substances.

150. Continuous Gas Chromatography. I. Pure Acetylene Recovery from End Gas of Partial Oxidation of Methane.

BENEDEK, P., SZEPESEY, L., FREUND, M. and LASZLO, A.

Acta Chim. Acad. Sci. Hung. **14** (1/2) 3-18 (1958). *Anal. Abstr.* **6** 202 (1959).

In English. A full description of a pilot plant for the chromatographic separation and recovery of acetylene using activated carbon, is given.

151. Continuous Chromatography (Hypersorption) on an Experimental Assembly.

BENEDEK, P., SZEPESEY, L. and NAD, Z.

Gazovaya Prom. 1958 No. 2 30-38. *Chem. Abstr.* **52** 9676 (1958).

Gives details of work on the separation of 4 types of gas mixture on activated carbon (Nuxit AL), using the Berg process.

152. The Calculation of the Continuous Gas Chromatographic Column.

BENEDEK, P., SZEPESEY, L. and SZEPE, S.

Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.

Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 225-236.

Theory and calculations for the separation of multicomponent mixtures of gases on a moving bed of activated carbon, using 3 different schemes.

153. Continuous Gas Chromatography. IV. Calculation of a Continuous Chromatographic Column for the Separation of Binary Mixtures.

BENEDEK, P., SZEPESEY, L. and SZEPE, S.

Acta Chim. Acad. Sci. Hung. **14** (3/4) 339-351 (1958). *Anal. Abstr.* **6** 786 (1959).

In English. Equations have been deduced for the operation of the column, and it is emphasised that the velocity of the carbon bed is extremely important, and that it should be kept to a minimum.

- 154. Continuous Gas Chromatography. V. Calculation of a 3-Product Gas Chromatographic Column.**
BENEDEK, P., SZEPESEY, L. and SZEPE, S.
Acta Chim. Acad. Sci. Hung. **14** (3/4) 353-358 (1958). *Anal. Abstr.* **6** 786 (1959).
In English. Similar equations to those in the previous reference are developed. It is necessary to employ 2 moving carbon beds in order to separate 2 components, 1 to adsorb material from the carrier gas and 1 to be used as a rectification column.
- 155. Continuous Gas Chromatography. VI. Calculation of a 2-Product Gas Chromatographic Column for Multicomponent Gaseous Feed.**
BENEDEK, P., SZEPESEY, L. and SZEPE, S.
Acta Chim. Acad. Sci. Hung. **14** (3/4) 359-367 (1958). *Anal. Abstr.* **6** 786 (1959).
In English. Equations are developed for a single column which will allow the separation of 1 pure compound from the components of a mixture.
- 156. Trace Analysis by Gas Chromatography.**
BENNETT, C. E., NOGARE, S. D., SAFRANSKI, L. W. and LEWIS, C. D.
Presented at the 131st National A.C.S. Meeting, Miami, Florida, April 1957. Abstracts p. 35B No. 90.
An apparatus for the analysis of impurities at a ppm level has been developed. It employs a direct current amplifier in conjunction with a thermistor detector to obtain the necessary sensitivity, and helium is used as carrier gas. Examples quoted were the determination of ppm of *iso*-propyl alcohol in benzene, benzene in toluene, methanol in water and cyclohexane in toluene.
- 157. Trace Analyses by Gas Chromatography.**
BENNETT, C. E., NOGARE, S. D., SAFRANSKI, L. W. and LEWIS, C. D.
Anal. Chem. **30** (5) 898-902 (1958). *Chem. Abstr.* **52** 13516 (1958).
See previous abstract.
- 158. The Work of the Department of the Government Chemist.**
BENNETT, G. M.
Proc. Congr. Modern Anal. Chem. in Industry. St. Andrews, Scotland. June 1957. 67-71. Published by Heffers, Cambridge, 1958.
This article contains a brief reference to gas chromatography using Scott's flame detector and a simple apparatus. The stationary phase used was polyethylene glycol 400 at 100°C which separated *m* + *p*-xylene from *o*-xylene and styrene.
- 159. Apparatus for Separation of Gaseous Hydrocarbon Mixtures by Selective Adsorption on Granular Charcoal.**
BERG, C. H. O.
U.S. 2,519,342-3-4 (1950). *Chem. Abstr.* **44** 9666 (1950).
Olefins and paraffins may be included in mixtures which make up the feed gas which comes from catalytic cracking processes. This selective adsorption process is proposed for the separation of C₁-C₃ hydrocarbons.

- 160. Quantitative Multicomponent Analysis. Part I. Gas Chromatographic Investigation of Phenol Mixtures.**
BERGMANN, G. and JENTZSCH, D.
Presented at a Meeting on 'The Analysis of Gaseous and Liquid Hydrocarbons and their Derivatives by Physical Methods'. Essen, January 1958. Printed in Z. anal. Chem. 164 (1) 10-29 (1958).
In German. Relative retention volumes of over 30 compounds related to phenol were determined on columns of *n*-decyl phthalate and silicone oil. The retentions are plotted against the boiling points of the compounds, and a theoretical discussion of the relationship is given. Quantitative separations may be obtained by correct choice of column and prior chemical treatment (methylation or ethylation).
- 161. Physical Methods in Chemical Analysis. Volume II.**
Ed. BERL, W. G. Published by Academic Press 1951.
Contains an article on 'Gas Analysis by Methods Depending on Thermal Conductivity' by E. R. Weaver. An abstract of this is given later under the author's name.
- 162. Physical Methods in Chemical Analysis. Volume III.**
Ed. BERL, W. G. Published by Academic Press 1956.
Contains an article on 'Gas Chromatography' by C. S. G. Phillips. An abstract of this appears later under the author's name.
- 163. Separation and Identification of some Terpenes by Gas-Partition Chromatographic Analysis.**
BERNHARD, R. A.
J. Assoc. Offic. Agr. Chemists 40 915-921 (1957). Chem. Abstr. 52 6068 (1958).
The author uses a column of polyethylene glycol (Carbowax 600) on diatomaceous earth at a temperature of 180°C with helium as carrier gas. The retention volumes of 5 terpenes occurring in commercial cold pressed lemon oil are given.
- 164. Examination of Lemon Oil by Gas-Partition Chromatography.**
BERNHARD, R. A.
Food Research 23 213-216 (1958).
Five peaks are obtained from a Carbowax column. Infra-red examination identifies (1) as α -pinene and (3) as limonene. Partial structures are assigned to (2) and (4), and (5) is held to be a mixture. Limits are proposed for peak height ratios for genuine American and Sicilian oils.
- 165. Variables Affecting Retention Time and Resolution in the Gas-Liquid Chromatographic Column.**
BEROES, C. S.
Univ. Microfilms Publ. No. 22843. Dissert. Abstr. 17 2229 (1957). Chem. Abstr. 52 1725 (1958).
No details given in *Chem. Abstr.*
- 166. A Critical Study of the Variables Affecting Retention Time and Resolution in the Gas-Liquid Chromatographic Column.**
BEROES, C. S.
Ph.D. Thesis—Univ. of Pittsburgh—June 1957. 106 pp.
See previous reference.

167. Separation of Mixtures of Methyl Ketones.

BERRIDGE, N. J. and WATTS, J. D.

J. Sci. Food Agr. **5** 417-421 (1954). *Chem. Abstr.* **49** 783 (1955).

Gas-liquid partition chromatography was used to separate the components of the mixtures, and it was found that more reliable results were obtained by collecting and analysing each separated fraction rather than by continuous titration of the effluent gas.

168. Determination of Oxygen Content of Air in Beer by Gas-Solid Chromatography.

BETHUNE, J. L. and RIGBY, F. L.

J. Inst. Brewing **64** (2) 170-175 (1958). *Anal. Abstr.* **6** 351 (1959).

Air from the beer package was collected over mercury, any beer carried over removed, and the gas transferred to a burette for measurement and removal of carbon dioxide. The residual gas was passed to a column of Molecular Sieve type 5A, the separation taking place at 103°C with helium as carrier gas and thermal conductivity detection.

169. Effect of Ascorbic Acid on Oxygen Content of Beer as Determined by Gas Chromatography.

BETHUNE, J. L. and RIGBY, F. L.

Proc. Am. Soc. Brewing Chemists 1958 62-65. *Chem Abstr.* **53** 5585 (1959).

A correction is reported to the method described in the previous abstract for the determination of oxygen in beer.

170. Qualitative Analysis of Organic Compounds by Mass Spectrometry.

BEYNON, J. H.

Nature **174** 735 (1954).

Vapour-phase chromatography offers an ideal method for the separation of mixtures into their component parts prior to analysis by mass spectrometry. See the next reference.

171. The Use of the Mass Spectrometer for the Identification of Organic Compounds.

BEYNON, J. H.

Mikrochim. Acta 1956 (1-3) 437-453. *Chem. Abstr.* **50** 8394 (1956).

The apparatus and methods used are fully described and a diagram of a gas chromatography apparatus is given. Mention is made of the usefulness of vapour-phase chromatography as a means of purification of samples before examination of their mass spectra, or in the examination of mixtures, where the mixture mass spectrum is too complex for complete analysis to be possible.

172. A Theory of the Gas-Liquid Chromatographic Process.

BEYNON, J. H., CLOUGH, S., CROOKS, D. A. and LESTER, G. R.

Trans. Faraday Soc. **54** (5) 705-714 (1958). *Chem. Abstr.* **53** 1890 (1959).

The assumption that all solute molecules spend equal times in the vapour-phase during their passage through the column was extended by the introduction of a parameter which can be described as a column 'merit' figure. An expression for the height of the equivalent theoretical plate was derived, taking into account gas diffusion.

- 173.** The Determination of Hydrogen in Head-Space Gases in Food Cans by Gas Chromatography.

BISHOP, J. R., LIEBMANN, H. and HUMPHREY, M.

Chem. and Ind. (London) 1957 (12) 360-362. Presented at a Meeting of Soc. Chem. Ind. Food Group, February 1957.

Hydrogen and oxygen are separated on a long column using carbon dioxide as carrier gas. If hydrogen, oxygen and nitrogen were applied to the column, the hydrogen emerged first. The eluent gas was passed through sodium hydroxide to remove carbon dioxide.

- 174.** Apparatus for Taking an Average Sample of a Variable Flow of Gas.

BLACKIE, A.

J. Soc. Chem. Ind. **58** (9) 293-296 (1939). *Chem. Abstr.* **34** 289 (1940).

A method for obtaining an average sample of a gas flowing in a pipe is described. By this method the influence of variations of gas velocity, pressure, density and temperature which affect the accuracy of most sampling methods may be eliminated. 2 forms of apparatus are described, 1 for small samples and 1 for larger ones, and means for meeting some of the practical difficulties are suggested.

- 175.** Apparatus for Taking an Average Sample of a Variable Flow of Gas.

BLACKIE, A.

J. Inst. Fuel **13** 98-101 (1940). *Chem. Abstr.* **34** 7146 (1940).

See previous reference.

- 176.** A New Technique for the Analysis of Essential Oils and Perfume Materials.

BLACKMORE, R. L. and FORDHAM, W. D.

Parfums, cosmet, savons. **1** (2) 54-56 (1958). *Chem. Abstr.* **52** 13195 (1958).

The principles of, and apparatus for, gas-liquid chromatography are briefly described. Chromatograms of 2 lemongrass oils of different origin are compared. A commercial citral shows peaks for citral *a* and *b*. Linalol, benzyl alcohol and phenylethyl alcohol are separated. Linalol shows only 1 peak at 155° but 3 at 180°C due to decomposition. This tendency is worse in linalyl acetate.

- 177.** Direct Titration of Carbon Dioxide.

BLOM, L. and EDELHAUSEN, L.

Anal. Chim. Acta **13** (2) 120-128 (1955). *Chem. Abstr.* **50** 2366 (1956).

The gas is absorbed in pyridine or acetone and titrated with a solution of sodium methoxide in methanol. The method is used to determine carbon dioxide in air and, on semi-micro and micro scales, carbon dioxide in combustion products.

- 178.** Vapour-Phase Chromatographic Determination of Benzene, Naphthalene and other Hydrocarbons in Wash Oil. Application of a Simple and Accurate Detection Method for Vapour-Phase Chromatography.

BLOM, L. and EDELHAUSEN, L.

Anal. Chim. Acta **15** (6) 559-566 (1956). *Chem. Abstr.* **51** 5637 (1957).

Approximately 100 ppm of benzene and varying percentages of naphthalene may be determined in wash oil by the methods described, which also enable other components of the wash oil to be determined. The

components are separated by vapour-phase chromatography and subsequently analysed. For this purpose an inexpensive detection method is used which is based on combustion over copper oxide and titration of the carbon dioxide produced. See previous reference.

179. The Thermal Conductivity of Gas Mixtures.

BOCK, H.

Ann. Physik. **8** 134-155 (1950). *Chem. Abstr.* **48** 11860 (1954).

Internal friction and heat conduction in gases are treated on the basis of models, and by the introduction of a term 'effective concentration' (whereby the concentration of the gas of lowest molecular weight appears to increase by the root of the mole-weight ratio), the relation between thermal conductivity and viscosity of pure gases can be extended to gas mixtures having the same effective concentration.

180. The Thermal Conductivity of Gas Mixtures.

BOCK, H.

Chem. Zentr. 1951 I 3306. *Chem. Abstr.* **48** 11860 (1954).

See previous reference.

181. Estimation of Trace and Major Quantities of Lower Alcohols, Ethers and Acetone in Aqueous Solutions by Gas-Liquid Partition Chromatography.

BODNAR, S. J. and MAYEUX, S. J.

Anal. Chem. **30** (8) 1384-1387 (1958). *Chem. Abstr.* **52** 16983 (1958).

The author uses a column packed with either triethylene glycol or polyethylene glycol 400 on C22 firebrick with helium as carrier gas.

182. The Use of Ozonolysis in Oil Constitution Research.

BOER, H.

Proc. 4th World Petrol. Congr. Sect. V/A Paper 1. Rome, 1955.

Gives a survey of the gas-liquid partition chromatography of fatty acids and mentions the use of titration apparatus, coulometry and an electrolytic conductivity cell.

183. A Comparison of Detection Methods for Gas Chromatography including Detection by Beta-Ray Ionisation.

BOER, H.

I.P. Symposium, London, 1956. 169-184.

Ed. DESTY, D. H. Published by Butterworths 1957.

The requirements that a method of detection for gas chromatography should fulfil are enumerated and described, and several of the available detecting systems are compared. It is concluded that methods employing thermal conductivity and ionisation by beta-rays at present appear to be particularly versatile and suitable for the purpose of general routine analysis. The beta-ray ionisation detector is described in some detail.

184. Gas Chromatography—A Method for Trace Analysis.

BOGGUS, J. D. and ADAMS, N. G.

Presented at the 22nd Meeting of the Gulf Coast Spectroscopic Group, Port Arthur, Texas, February 1957.

See the following reference.

185. Gas Chromatography for Trace Analysis.

BOGGUS, J. D. and ADAMS, N. G.

Anal. Chem. **30** (9) 1471-1473 (1958). *Chem. Abstr.* **52** 19669 (1958).

A technique is presented which shows the adaptability of gas chromatography to the analysis of a plant stream of ethyl chloride of 99% purity. A primary separation is carried out on a 10 ft by $\frac{1}{2}$ in. O.D. column containing Nujol on C22 firebrick at 40°C. and a second separation is run at 30°C using hexane as internal standard. The carrier gas in both cases is either nitrogen or helium.

186. Katharometric Measurement of Theoretical Plate Numbers in Gas Chromatography.

BOHEMAN, J. and PURNELL, J. H.

Chem. and Ind. (London) 1957 (25) 815-816. *Chem. Abstr.* **51** 15324 (1957).

From the experiments described, it is clear, both from the analytical and theoretical standpoints, that considerable caution must be exercised in the use of katharometers with nitrogen or carbon dioxide as carrier gases, and this is particularly so at high temperatures.

187. The Behaviour of Katharometers for Gas Chromatography in Carrier Gases of Low Thermal Conductivity.

BOHEMAN, J. and PURNELL, J. H.

J. Appl. Chem. (London) **8** (7) 433-440 (1958). *Chem. Abstr.* **52** 19269 (1958).

Particular attention is paid to the phenomena of partial and complete reversal of chromatographic peaks. Forced convection has been found an important factor in nitrogen, and this behaviour can be explained if heat capacity as well as thermal conductivity changes are considered.

188. Some Applications of Theory in the Attainment of High Column Efficiencies in Gas-Liquid Chromatography.

BOHEMAN, J. and PURNELL, J. H.

Gas Chromatography 1958. *Amsterdam Symposium, May 1958.**Ed. DESTY, D. H. Published by Butterworths 1958. 6-17. Discussion 18-22.*

The effect of certain variables (support size, uniformity of particle size, carrier gas and sample size), on the H.E.T.P. of polyethylene glycol 400 Silocel columns has been studied using cyclohexane, acetone, benzene and isopropanol as solutes. The results are discussed in terms of the rate theory and the performance index, and the requirements for high column efficiencies are outlined.

189. An Electronic Voltage Amplifier for Indirect Registration in Gas Chromatography.

BOHM, Z.

Chem. listy. **52** 359-360 (1958). *Chem. Abstr.* **52** 19285 (1958).

A description is given of an amplifier which is suitable for amplifying a d.c. voltage with a slowly varying potential.

190. On Microthermal Conductivity Gauges.

BOLLAND, J. L. and MELVILLE, H. W.

Trans. Faraday Soc. **33** (9) 1316-1329 (1937). *Chem. Abstr.* **31** 8264 (1937).

Improvements in the design of a small thermal conductivity cell are described. A theory was developed and discussed to account for the behaviour of the gauges when filled with H₂, D₂, H₂/D₂ and H₂/HD/D₂.

191. The Selective Hydrogenation of Acetylene.

BOND, G. C., DOWDEN, D. A. and MACKENZIE, N.

Trans. Faraday Soc. **54** (10) 1537-1546 (1958).

Describes the analysis by gas-liquid chromatography of the ethylene/ethane ratio in reaction products, using a 16 ft column packed with tetra-isobutylene on firebrick, and hydrogen as carrier gas. Both column and thermal conductivity cells were at room temperature.

192. The Diffusion at a Front in Gas Chromatography.

BOSANQUET, C. H.

Gas Chromatography 1958. *Amsterdam Symposium, May 1958.**Ed. DESTY, D. H. Published by Butterworths 1958. 107-114. Discussion 114-115.*

Adsorption and desorption of vapour in a gas chromatographic column causes changes in the gas flow velocity which are shown to depend on vapour concentration and, to a lesser extent, on the concentration gradient. Diffusion equations governing the phenomenon are developed and the equations relating to the spreading of a simple front are solved.

193. The Concentration Factor in Vapour-Phase Partition Chromatography.

BOSANQUET, C. H. and MORGAN, G. O.

*I.P. Symposium, London, 1956. 35.**Ed. DESTY, D. H. Published by Butterworths 1957.*

Unsymmetrical peaks in vapour-phase partition chromatography need not be due to non-linear partition. With propylene or propane as solute and tri-isobutene as solvent on Celite, the isotherms are linear, but the peaks are unsymmetrical. Using the method of frontal analysis with nitrogen or hydrogen as carrier gas, the transition region both for saturation and elution is found to be proportional to the time the region is on the column.

194. Determination of Hydrogen in Water by means of Gas Chromatography.

BOVIJN, L., PIROTTE, J. and BERGER, A.

Gas Chromatography 1958. *Amsterdam Symposium, May 1958.**Ed. DESTY, D. H. Published by Butterworths 1958. 310-319. Discussion 319-320.*

The determination of traces of hydrogen in water (1 microgram per kilogram) is of importance as a means of controlling water corrosion in the tubes of high pressure boilers. An original sampling technique that is based on the partition of the dissolved uncondensable gas between the water-phase and the gas-phase has been developed.

195. Determination of Impurities in Inert Gases.

BOWMAN, R. E. and HARTLEY, C. B.

Welding J. (N.Y.) **29** (5) 258S-262S (1950). *Chem. Abstr.* **44** 9297 (1950).

Equipment and techniques were developed for determining the total impurities in argon and helium. The method is based on the fact that molten lithium absorbs nitrogen, oxygen and water. The gas sample was admitted into a constant volume apparatus where the impurities were removed by molten lithium. The change in the pressure at a standard temperature produced by the removal of the impurities was used to determine the purity of the gas.

- 196.** A Microsample Introduction System for Gas Chromatography.
BOWMAN, R. L. and KARMEN, A.
Nature **182** (4644) 1233-1234 (1958). *Chem. Abstr.* **53** 4826 (1959).
A sample introduction system permitting a reproducible injection of known volumes in the microgram range is described and illustrated.
- 197.** The Exchange Adsorption of Ions from Aqueous Solutions by Organic Zeolites. III. Performance of Deep Adsorbent Beds under Non-Equilibrium Conditions.
BOYD, G. E., MYERS, L. S. and ADAMSON, A. W.
J. Am. Chem. Soc. **69** (11) 2849-2859 (1947). *Chem. Abstr.* **42** 1782 (1948).
Mainly a theoretical treatment of column performance.
- 198.** The Chromatographic Analysis of Hydrocarbon Mixtures.
BRADFORD, B. W., HARVEY, D. and CHALKIEY, D. E.
J. Inst. Petrol. **41** (375) 80-91 (1955). *Chem. Abstr.* **49** 7839 (1955).
Vapour-phase chromatography in its present stage of development has considerable advantages in speed and resolving power for components in the lower molecular weight range. Upward extension of the effective molecular weight range is an objective which can be approached in several ways, and work continues on this. Although this paper deals only with the analysis of hydrocarbon mixtures, vapour-phase chromatography has wide applicability to other classes of compounds.
- 199.** Process Analytical Control; The Problems of Manpower, Productivity and Automation.
BRADFORD, B. W. and NICHOLSON, D. L.
Proc. Congr. Modern Anal. Chem. in Industry, St. Andrews, Scotland. June 1957. 161-167. Published by Heffers, Cambridge, 1958.
Gas chromatography is of great importance in process analytical control, and has replaced older methods of analysis in some cases. An example of the separation of low boiling point hydrocarbons is given. The method is likely to be of greatest value when directly coupled to process streams by means of an automatic sampler.
- 200.** Measurement of Vapour Pressures by Means of Matched Thermistors.
BRADY, A. P., HUFF, H. and McBAIN, J. W.
J. Phys. and Colloid Chem. **55** 304-311 (1951). *Chem. Abstr.* **45** 4530 (1951).
The thermocouples and galvanometer of a Hills-Baldes apparatus are replaced by thermistors incorporated in an a.c. bridge unit.
- 201.** New Methods of Analysis.
BRANCH, R. F.
Can. Chem. Processing **40** (11) 105-106 (1956), **40** (12) 80-84 (1956). *Chem. Abstr.* **51** 6423 (1957).
Gas chromatography is included among the new developments described and discussed.
- 202.** Relation Between Pressure Drop and Rectifying Action in Packed Columns.
BRAUER, H.
Chem. Ing. Tech. **29** 520-530 (1957). *Chem. Abstr.* **51** 16011 (1957).
A comprehensive review of the literature, including the results of some original experiments, with a full description of the experimental method used.

203. New Synthetic Crystalline Zeolites.

BRECK, D. W., EVERSOLE, W. G. and MILTON, R. M.

J. Am. Chem. Soc. **78** (10) 2338-2339 (1956). *Chem. Abstr.* **50** 11180 (1956).

An introductory article describing preliminary work on these zeolites. See the following reference.

204. Crystalline Zeolites. I. The Properties of a New Synthetic Zeolite, Type A.

BRECK, D. W., EVERSOLE, W. G., MILTON, R. M., REED, T. B. and THOMAS, T. L.

J. Am. Chem. Soc. **78** (23) 5963-5971 (1956). *Chem. Abstr.* **51** 5498 (1957).

The properties of a new zeolite are announced. Removal of crystal water leaves a stable crystalline solid containing mutually connected intercrystalline voids amounting to 45 vol% of the zeolite. A high capacity adsorbent is produced which readily occludes molecules of a certain size and shape but excludes others. Replacement of sodium by calcium effectively enlarges the pore openings so that straight chain hydrocarbons are readily adsorbed but branched chain hydrocarbons are excluded.

205. A Microflame Apparatus for High Temperature Gas Chromatography.
BREDEL, H.

Presented at the Symposium on Gas Chromatography, Leipzig, October 1958. Preprints 1-21.

In German. Describes the construction of apparatus suitable for the separation of high boiling point compounds. Essential features are low cost and construction from readily available materials. Formulae are given for the quantitative evaluation of chromatograms.

206. Gas-Phase Chromatography: A Class Experiment.

BRENNAN, D. and KEMBALL, C.

J. Chem. Educ. **33** (10) 490-492 (1956). *Chem. Abstr.* **51** 2343 (1957).

Describes an experiment to separate ether, acetone and methylene dichloride on a 6 ft by 5 mm column packed with dinonyl phthalate on Celite 545, and using thermal conductivity detection. Instructions for making a simple apparatus are also included.

207. Resolution in Gas-Liquid Chromatography.

BRENNAN, D. and KEMBALL, C.

J. Inst. Petrol. **44** (409) 14-17 (1958). *Chem. Abstr.* **52** 5088 (1958).

The effects on resolution of variations in flow rate, pressure and column length were studied, and the van Deemter equation tested for these parameters. It was found to be satisfactory even for columns having a comparatively small number of theoretical plates.

208. Applications of Gas Chromatography to Toilet Goods Analysis.

BRENNER, N.

Proc. Sci. Sect. Toilet Goods Assoc. **26** 3-8 (1956). *Chem. Abstr.* **51** 3934 (1957).

A review which gives a general description of the apparatus and procedure usually employed. No further details available.

209. Light Gas Analysis Using Gas Chromatography.

BRENNER, N.

Presented at the Southwide Chem. Conf. on Instrumentation, Instr. Soc. Am. Symposium on Gas Chromatography, Memphis, Tennessee, December 1956.

No further details available.

210. Special Application of Gas Chromatography Equipment to Chemical Laboratory Problems.

BRENNER, N.

Presented at 8th Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, March 1957. Abstract in Appl. Spectroscopy 11 (2) 101 (1957).

The use of gas chromatography for the preparation of pure compounds and as an aid in qualitative analysis is discussed.

211. Modification of a Gas Chromatography Instrument for Special Laboratory Problems.

BRENNER, N.

Presented at the 131st National A.C.S. Meeting, Miami, Florida, April 1957. Abstracts p. 36B No. 93.

Describes the use of columns of differing diameters for the separation and preparation of pure samples. Data showing the effect of column diameter on resolution, sample capacity and instrument behaviour are presented, and an automatic apparatus is described.

212. Gas Chromatography.

BRENNER, N.

Drug and Cosmetic Ind. 80 166-167, 261-266 (1957). Chem. Abstr. 51 9085 (1957).

A discussion of applications useful to the cosmetic chemist.

213. Analytical Applications of a Triple Stage Gas Chromatography Instrument.

BRENNER, N.

Presented at the Pittsburgh Conf. on Anal. Chem. March 1958. Paper 112.

No further details available.

214. Modification of Vapour-Phase Chromatography Apparatus for Preparation of High Purity Compounds.

BRENNER, N. and COATES, V. J.

Presented at Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, March 1957.

No further details available, but probably similar to reference 211.

215. Molecular Sieves as Subtractors in Gas Chromatographic Analysis.

BRENNER, N. and COATES, V. J.

Nature 181 (4620) 1401-1402 (1958). Chem. Abstr. 52 15884 (1958).

A property of molecular sieves is their selective retention of *n*-paraffins in mixtures of *n*-, *iso*-, *cyclo*- and aromatic paraffins. They also show a similar irreversible adsorptivity in other homologous series. Some experiments are described on a 50 ft column of β,β -oxydipropionitrile on Chromosorb at a temperature of 81°C.

216. The Analysis of Tar Acids by Gas Chromatography.

BRENNER, N. and KIRBY, G.

Presented at the Southeastern Regional Meeting of the Local Sections of A.C.S., Durham, November 1957.

No further details available.

217. The Theory of Nonequilibrium Chromatography.

BRESLER, S. E..

Doklady Akad. Nauk. S.S.S.R. **90** 205-208 (1953). *Chem. Abstr.* **49** 8725 (1955).

See reference 221.

218. Theory of Nonequilibrium Chromatography. The Formation of a Stationary Front of the Zone.

BRESLER, S. E.

Doklady Akad. Nauk. S.S.S.R. **97** 699-702 (1954). *Chem. Abstr.* **51** 8508 (1957).

A basic differential equation reported in a previous paper (see reference 221), has been simplified. Solutions for frontal and elution analysis are written. A longer abstract is available in *Chem. Abstr.*

219. Zone Diffusion in Chromatography.

BRESLER, S. E.

Khromatografiya, Leningrad. Gosudarst. Univ. im. A. A. Zhdanova, Sbornik Statei. 1956 106-126. *Chem. Abstr.* **52** 8675 (1958).

A theoretical paper on zone diffusion in both equilibrium and nonequilibrium chromatography.

220. The Theory of Chromatographic Separation of Isotopes.

BRESLER, S. E.

Zhur. Fiz. Khim. **32** 628-634 (1958). *Chem. Abstr.* **52** 14282 (1958).

Isotope separation on a chromatographic column is described by means of a differential equation which applies to either the steady or the non steady state. The maximum separation and the time taken to reach a steady state distribution may be derived from this equation.

221. The Theory of Nonequilibrium Chromatography.

BRESLER, S. E. and UFLYAND, Y. S.

Zhur. Tekh. Fiz. **23** 1443-1451 (1953). *Chem. Abstr.* **49** 3717 (1955).

Adsorption on the particles of an adsorbent is not an equilibrium value, but a differential equation has been derived which describes this condition. The equation can be solved by using Laplace transfers.

222. Degree of Purification of Hydrogen and Helium by a Chromatographic Process on Activated Carbon.

BRILLYANTOV, N. A. and FRADKOV, A. B.

Soviet Phys.-Tech. Phys. **2** 2239-2244 (1957) (*English translation*). *Zhur. Tekh. Fiz.* **27** 2404-2409. *Chem. Abstr.* **52** 17893 (1958).

Nitrogen and oxygen were removed from hydrogen and helium by chromatography on activated carbon, and the degree of purification determined from the adsorption isotherms for nitrogen and oxygen.

223. Practical Chromatography.

BRIMLEY, R. C. and BARRETT, F. C.

Published by Chapman and Hall 1954. 128 pp.

This book contains sections giving general descriptions of:—(1) adsorption chromatography of gases and vapours (56-60) and (2) gas-liquid partition chromatography (71-77). The sections are mainly accounts of early work, and as such are interesting for the background they provide to the subject of gas chromatography.

- 224.** 'Linde' Molecular Sieves for Selective Adsorption. Free booklet, 28 pp.
Published by The British Drug Houses Ltd., Poole, Dorset.
Gives a full description of the properties and applications of these molecular sieves. A bibliography is included.
- 225.** Analysis and Separation of Gaseous Hydrocarbons by the Adsorption Method.
BRODSKII, A. M., KALINENKO, R. A. and LAVROVSKII, K. P.
Khim. i. Tekhnol. Topliva 1956 (8) 18-22. *Chem. Abstr.* **51** 135 (1957).
An adsorption apparatus was designed and its performance evaluated using a 12 component hydrocarbon mixture (up to C₄).
- 226.** On the Radiolysis of Heptane.
BRODSKII, A. M., KOLBANOVSKY, Y. A., FILATOVA, E. D. and TCHERNYSHEVA, A. S.
Doklady Akad. Nauk. S.S.S.R. **122** (6) 1035-1038 (1958).
Gas-liquid chromatography was used to analyse the radiolysis products of heptane. The sample size was 0.5 ml of gas for up to C₅ hydrocarbons with a quantitative accuracy of 2-5%.
- 227.** Thermal Conductivity of Gases at Moderate Pressures.
BROMLEY, LeRoy A.
U.S. Atomic Energy Comm. Tech. Inform. Service UCRL-1852 31 pp. (1952). *Chem. Abstr.* **48** 417 (1954).
Theoretical and experimental data are combined in order to develop an equation from which thermal conductivity may be calculated. Linear, non-linear, polar and non-polar molecules are all considered, and the effects of pressure and composition are discussed.
- 228.** A Rapid Method for the Determination of the Aromatic Content of Petroleum Fractions Boiling Above the Kerosine Range.
BROOK, B. M. and WHITHAM, B. T.
J. Inst. Petrol. **44** 212-215 (1958). *Chem. Abstr.* **52** 15307 (1958).
Describes the use of selective adsorption on silica gel in a small-scale elution technique for the separation of saturated and aromatic hydrocarbons.
- 229.** Apparatus for Vapour-Phase Chromatography. Analysis of Pyridine Homologues. Separation of the Isomers of Picoline.
BROOKS, J., MURRAY, W. and WILLIAMS, A. F.
15th Int. Congr. Pure and Appl. Chem., Lisbon, September 1956.
No further details available, but the subject matter appears similar to that described in reference 232.
- 230.** Apparatus for Vapour-Phase Chromatography with Ancillary Unit for the Determination of Isopropyl Nitrate in Heavy Oils.
BROOKS, J., MURRAY, W. and WILLIAMS, A. F.
I.P. Symposium, London, 1956. 281-290.
Ed. DESTY, D. H. Published by Butterworths 1957.
The apparatus is based on the use of glass thermal conductivity cells. The column and conductivity cells are housed in a single metal unit and can be readily heated to a uniform temperature by vapour from a boiling solvent. The construction of the katharometer is discussed, and some of the factors affecting its sensitivity have been investigated.

231. Gas-Liquid Chromatography—Separation of Hydrocarbons using Various Stationary Phases.

BROOKS, V. T. and COLLINS, G. A.

Chem. and Ind. (London) 1956 (35) 921. *Chem. Abstr.* **51** 3234 (1957).

The column support was in all cases kieselguhr purified as described by James and Martin, and the apparatus was that of Ray. Relative retention volumes are listed for 30 hydrocarbons using the following liquid phases on the column:—Nujol (liquid paraffin), dinonyl phthalate, tri-xylene phosphat e, polyethylene glycol 1000, polypropylene glycol 2025, and methoxy polyethylene glycol 550.

232. Separation of Pyridine Bases by Vapour-Phase Chromatography.

BROOKS, V. T. and COLLINS, G. A.

Chem. and Ind. (London) 1956 (38) 1021. *Chem. Abstr.* **51** 2355 (1957).

The separation of pyridine, picolines, lutidine, collidine and their esters has been investigated using various column liquids. Nujol, tri-xylene phosphat e, polyethylene glycol 1000, silicone M 430, triethanolamine and glycerol were tried. Glycerol was the only one to completely resolve picolines.

233. Gas Analysis by Thermal Conductivity Measurement.

BROWN, G. B. and DEAN, R. W.

Instr. Engr. **1** (7) 145-150 (1955). *Anal. Abstr.* **2** 2636 (1955).

The suitability and limitations of the thermal conductivity method of obtaining continuous gas analyses are discussed, and a description is given of equipment suitable for industrial measurements. Some theoretical aspects of flue gas analysis are considered, and it is shown that the measurement of the carbon dioxide content of such gas may be achieved by the method. Reference is also made to the sampling requirements for this application. Other applications, including those involving the use of 2 measuring cells, are described.

234. Process Analytical Instrumentation.

BROWN, J. F. and STANLEY, A. G.

Trans. Soc. Instr. Tech. **8** (4) 156 (1956).

Contains a short section on gas chromatography, and gives a flow sheet of a gas chromatography apparatus with a graph showing hydrocarbon separation.

235. Interpretation of Areas Used for Quantitative Analysis in Gas-Liquid Partition Chromatography.

BROWNING, L. C. and WATTS, J. O.

Anal. Chem. **29** (1) 24-27 (1957). *Chem. Abstr.* **51** 11911 (1957).

In compounds where the differences in thermal conductivity are small, peak areas may be used to determine the weight % directly. Where the thermal conductivities differ considerably, the % calculated directly from peak areas do not give correct weight % values. If, however, the individual areas are divided by the thermal conductivity of the compound, the weight % may be obtained with reasonable accuracy. The analysis of mixtures of water/ethanol/di-ethyl ether, carbon tetrachloride/acetone, ethanol/chloroform and carbon tetrachloride/chloroform by gas chromatography were used in this investigation.

236. Separation of Gases by Means of Permeable Membranes ; Permeability of Plastic Membranes to Gases.

BRUBAKER, D. W. and KAMMERMEYER, K.

Ind. Eng. Chem. **44** (6) 1465-1474 (1952). *Chem. Abstr.* **46** 9932 (1952).

The permeabilities of carbon dioxide, hydrogen and oxygen for a variety of gas/film combinations have been obtained. Plastic films investigated included experimental and commercial products e.g. ethyl cellulose, polystyrene, vinyl, polythene, etc. The effect of temperature is not readily predictable, and it is recommended that data should be obtained at 2 or 3 temperatures. The effect of plasticisers was also investigated.

237. The Thermal Decomposition of 1-Butene and 1-Butene-4-d₃.

BRYCE, W. A. and KEBARLE, P.

Trans. Faraday Soc. **54** (11) 1660-1677 (1958).

The reaction products were determined by gas chromatography and mass spectrometry, C₁-C₄ components were separated on columns of alumina with rising column temperature, but for higher compounds, tricresyl phosphate on Celite 545 was used. The carrier gas was helium with thermal conductivity detection.

238. Chromothermographic Analysis of Gaseous Hydrocarbons.

BUCUR, R.

Rev. Chim. (Bucharest) **7** (3) 163-165 (1956). *Chem. Abstr.* **52** 9856 (1958).

A new chromatographic technique for the complete separation of the components of a gaseous mixture is described. It combines development and thermal desorption, and uses an electric heater round a column packed with silica gel to provide a temperature gradient. A thermal conductivity detector is used.

239. Development of a Laboratory Vapour-Phase Chromatograph.

BUMB, F. C. and MARKS, M. L.

Presented at the Southwide Chem. Conf. on Instrumentation. Instr. Soc. Am. Symposium on Gas Chromatography. Memphis, Tennessee, December 1956.

No further details available.

240. The Radiolysis and Mass Spectrometry of Several Deuterated Ethanols.

BURR, J. G.

J. Phys. Chem. **61** 1477-1480 (1957). *Chem. Abstr.* **52** 3535 (1958).

Describes the use of a vapour fractometer to check the purity of deuterated ethanols for traces of water.

241. The Radiolysis of Deuterated and Tritiated Acetic Acids.

BURR, J. G.

J. Phys. Chem. **61** 1481-1483 (1957). *Chem. Abstr.* **52** 3535 (1958).

A vapour fractometer was used to check the water content of formic acid, etc.

242. Revealing Facts about Temperature Control in Gas and Vapour Chromatography.

Burrell Corp. Bulletin 838 (1958). 8 pp.

Manufacturers literature describing the Burrell Kromo-Tog. Briefly discusses the significance of column temperature, retention time, detector temperature, resolution and temperature programming.

243. Some Features of Gas-Liquid Chromatography.

BURROWS, G.

Trans. Inst. Chem. Engrs. **35** (4) 245-257 (1957). *Anal. Abstr.* **5** 1089 (1958).

From an examination of the process of gas chromatography, it is concluded that the controlling factor is solubility. The solubility coefficient, pore size and thickness of the liquid layer have been combined to derive an equation which gives results which are in agreement with experimental findings. Effects of sample size and column operating temperature are discussed.

244. Point of Attack in Hydrocarbon Oxidation.

BURT, R., EBEID, F. B. and MINKOFF, G. J.

Nature **180** (4578) 188 (1957). *Chem. Abstr.* **52** 3675 (1958).

The article mentions that aldehydes from C_2 to C_6 were identified in the reaction products of the slow oxidation of *n*-heptane by the use of gas-phase chromatography, but no experimental details are given.

245. Thermal Conductivity of Gas Mixtures in Chemical Equilibrium.

BUTLER, J. N. and BROKAW, R. S.

J. Chem. Phys. **26** 1636-1643 (1957). *Chem. Abstr.* **51** 17389 (1957).

The increase in thermal conductivity following a chemical reaction in gas mixtures in chemical equilibrium may be calculated from a general expression which is given. The systems $2NO_2 = N_2O_4$ and $6HF = (HF)_6$ were both checked by calculation and experiment and found to be in agreement.

246. Vapour-Phase Partition Chromatography. I.

BUZON, J. and MOGHADAME, P. E.

Rev. inst. franc. petrole et Ann. combustibles liquids **11** 1616-1628 (1956). *Chem. Abstr.* **51** 17302 (1957).

The retention of benzene by dinonyl phthalate has been studied by elution with nitrogen at various pressures using thermal conductivity detection.

247. Radiolysis of Pentane Adsorbed on Mineral Solids.

CAFFREY, J. M. and ALLEN, A. O.

J. Phys. Chem. **62** 33-37 (1958). *Chem. Abstr.* **52** 7877 (1958).

Vapour-phase chromatography was used to test the purity of the initial *n*-pentane and the products of gamma irradiation. The stationary phase was tri-*m*-cresyl phosphate, and this allowed the separation of (ethylene + ethane), propane, propylene and *iso*- and *n*-butane from butylenes. The products from the irradiation differed widely for the different solids, and were quite different from those from the radiolysis of the bulk liquid.

248. Microsampling Method of Determining Gases and Vapours, Particularly Halogenated Hydrocarbons in Air.

CALL, F.

J. Appl. Chem. (London) **7** 210-215 (1957). *Chem. Abstr.* **51** 16206 (1957).

An apparatus is described for drawing an accurately measured sample through a combustion tube and adsorption vessel. The bromine produced is estimated by measuring the change in absorption of a solution of phenol red in a phosphate buffer.

- 249.** The Application of Gas-Liquid Partition Chromatography to Problems in Chemical Kinetics.

CALLEAR, A. B. and CVETANOVIC, R. J.

Presented at 38th Ann. Conf. Chem. Institute of Canada, Quebec, May 1955. Abstract in Chem. in Canada 7 (5) 53 (1955).

The analysis of mixtures of the order of a micromole is described, and the experimental factors affecting the sensitivity of the method are emphasised. Celite may be replaced by small glass beads in order to reduce peak 'tailing'.

- 250.** Application of Gas-Liquid Partition Chromatography to Problems in Chemical Kinetics.

CALLEAR, A. B. and CVETANOVIC, R. J.

Can. J. Chem. **33** 1256-1267 (1955). *Chem. Abstr.* **49** 14421 (1955).

See previous reference. A method is described, sensitive to 10^{-8} mole, which allows a column to be used indefinitely. The separated components were detected by thermal conductivity. 3 columns were used in the investigation:—glass spheres coated with dinonyl phthalate, or with glycerol, and dinonyl phthalate on Celite.

- 251.** An Experimental Method of Measuring the Thermal Conductivity of Gases.

CALLEAR, A. B. and ROBB, J. C.

Trans. Faraday Soc. **51** 630-638 (1955). *Chem. Abstr.* **49** 14390 (1955).

Heat was supplied to the gas by a wire, and the temperature produced measured by another wire at some distance from the first. Temperature discontinuities were eliminated by this method. An accuracy of about 1% was obtained.

- 252.** Fractography (Chromatography) of Gases and Vapours.

CALLISEN, F. I.

Ind. y. quim. (Buenos Aires) **18** 226-229 (1957). *Chem. Abstr.* **52** 2639 (1958).

A general description of gas chromatography, giving the principles of its operation, some applications and its advantages over other methods. The term 'fractography' is preferred to 'chromatography'.

- 253.** Gas Chromatography Applied to Essential Oils and their Constituents.

CALVARANO, M.

Essenze deriv. agrumari **27** 208-220 (1957). *Chem. Abstr.* **52** 10507 (1958).

A review giving 66 references.

- 254.** Vapour-Phase Partition Chromatography of the Essential Oils of the Mandarin.

CALVARANO, M.

Essenze deriv. agrumari **28** 107-118 (1958).

By direct chromatography on polyethylene glycol at 110°C , α -pinene, camphene, β -pinene, γ -phellandrene, δ -limonene, *p*-cimene and other terpenes were eluted in that order. A fraction from which free acids, phenols and terpenes had been removed, was chromatographed at 184°C , and linalol, linalyl acetate, an unidentified peak, terpinyl acetate, terpinol and nerol were eluted in that order.

- 255.** Reaction of Chlorodifluoromethane with Linde Molecular Sieve 5A.
CANNON, P.
J. Am. Chem. Soc. **80** (7) 1766-1767 (1958). *Chem. Abstr.* **52** 11730 (1958).
The compound was stored over the molecular sieve for 3 weeks at 25°C, after which it contained 0.4% of carbon dioxide which had not been present before the test. The analyses were carried out by gas chromatography.
- 256.** Application of Gas Chromatography to Studies of Pre-Flame Combustion in a Motored Engine.
CANNON, W. A.
Presented at 5th Annual Anachem. Conf., Dearborn, Michigan, October 1957.
No further details are available.
- 257.** Design and Performance of the Beckman Gas Chromatograph.
CARLE, D. W.
Presented at the Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, February 1956.
An apparatus of compact size—20 in. × 16 in. × 9 in., not including a recorder—has been designed. A flat spiral column is used and a special sample introducing valve is incorporated. The electrical circuits use a filament type detector and a polarity switch to take care of negative peaks. An example of the analysis of natural gas (methane to pentanes) was given.
- 258.** The Role of Column Packing Materials and Carrier Gases.
CARLE, D. W.
Proc. 31st Annual Meeting, California Natural Gas Assn., Los Angeles, November 1956. 5-9. Reported in Oil Gas J. **54** (85) 128, 131-132 (1956).
A discussion on the selection of carrier gases from the point of view of thermal conductivity, diffusion rate, chemical inertness, molecular weight and safety, with notes on several gases which are used for this purpose. Column packing materials for both adsorption and liquid partition columns are also described and discussed.
- 259.** A New High Temperature Gas Chromatograph.
CARLE, D. W.
Presented at the Pacific S.W. Regional Meeting, Am. Chem. Soc., California, April 1957.
See reference 262.
- 260.** Precise Liquid Sampling in Gas Chromatography.
CARLE, D. W.
Gas Chromatography—Instr. Soc. Am. Symposium, August 1957.
Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 67-72.
Describes fully, with an exploded diagram, the Beckman liquid sampler which uses a positive displacement system, and has several inherent advantages. The design is discussed and the evaluation of its performance reported.
- 261.** Preparative Scale Gas Chromatography.
CARLE, D. W. and BURNELL, M.
Presented at the Pittsburgh Conf. on Anal. Chem., March 1958. Paper 114.
No further details are available.

- 262.** Design and Performance of a New High Temperature Gas Chromatograph.

CARLE, D. W. and DONNER, W.

Presented at 8th Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, March 1957. Abstract in Appl. Spectroscopy **11** (2) 101 (1957).

A completely new instrument, incorporating high sensitivity and stability. The temperature is electrically controlled from ambient to over 200°C, and other features include column interchange, precise flow control and a versatile gas sampling valve.

- 263.** Flow of Gases through Porous Media.

CARMAN, P. C.

Published by Butterworths 1956.

Provides a quantitative account of the flow processes involved when gases flow into or through fine-pored media. The subject is approached from the viewpoint of the Kozeny theory. Its limitations are fully discussed for consolidated media, for high porosities and for relative permeability, with particular attention to the question of pore size distribution. Recent work on surface diffusion and capillary flow of adsorbable gases in fine-pored systems is reviewed. A chapter is included on the use of porous media for gas separations, and includes a discussion of gas chromatography.

- 264.** Chromatography of Gases—Technique of Gas-Liquid Distribution.

CAROTI, G.

Riv. combustibili **10** 456-471 (1956). *Chem. Abstr.* **50** 15324 (1956).

The technique of gas-liquid partition chromatography is described.

- 265.** Gas-Liquid Partition Chromatography of Mixtures of Aryl Methyl Ethers.

CARRUTHERS, W., JOHNSTONE, R. A. W. and PLIMMER, J. R.

Chem. & Ind. (London) 1958 (11) 331. *Chem. Abstr.* **52** 12678 (1958).

The analysis is carried out on a column 260 cm long, packed with Apiezon M on Celite 22 at a temperature of 145°C, and using nitrogen as carrier gas.

- 266.** Gas-Liquid Chromatography of the Volatile Components of Onions.

CARSON, J. F. and WONG, F. F.

Advances in Gas Chromatography—Am. Chem. Soc. Symposium—New York, September 1957. Published by Am. Chem. Soc. 1957. D-115.

Only an abstract is given. Several stationary phases were studied, including Apiezon M, Silicone SF 96-40, polystyrene glycol, octylphenoxypolyethylene glycol and polyethylene glycol. The latter 2 were found to be the most suitable, as they allowed the separation of dipropyl sulphide, allyl propyl disulphide and diallyl sulphide at 140°C.

- 267.** Technique of Organic Chemistry. Volume V. Adsorption and Chromatography.

CASSIDY, H. G.

Ed. WEISSBERGER, A. Published by Interscience 1951. 355 pp.

Does not include a description of gas chromatography as such, but contains some very useful information on all aspects of adsorption, its measurement and relations between adsorption and the properties of the adsorptive. Lists and properties of various adsorbents are given.

268. The Nature of Chromatography.

CASSIDY, H. G.

J. Chem. Educ. **33** (10) 482 (1956).

A general review of what chromatography is and a description of the various types. It contains a short general description of gas chromatography, detailing the types and the general technique of operation.

269. The Nature of Chromatography.

CASSIDY, H. G.

Presented at 129th Meeting Am. Chem. Soc., Dallas, Texas, April 1956. Abstracts p. 13B No. 35.

The special place of gas chromatography amongst the other chromatographic methods is pointed out, and thus its relationship to other analytical techniques.

270. Technique of Organic Chemistry. Volume X. Fundamentals of Chromatography.

CASSIDY, H. G.

Ed. WEISSBERGER, A. Published by Interscience 1957. 447 pp.

A comprehensive book on the theory and principles of chromatography. Chapter V (pp. 77-105), deals with gas-liquid partition chromatography, covering apparatus, procedure, quantitative theory, the choice of phases, practical considerations, etc.

A review of this volume appeared in *Nature* **180** 773 (1957).

271. Purity of Chloroform B.P.

CAWS, A. C. and FOSTER, G. E.

J. Pharm. & Pharmacol. **9** 824-832 (1957). *Chem. Abstr.* **52** 4927 (1958).

It is shown by gas chromatography that chlorobromomethane is present in Chloroform B.P.

272. New Uses for Gas Chromatography in Process and Product Quality Control.

CHADD, G. K. and WHITE, G. B.

Presented at the Southwest Regional Meeting Am. Chem. Soc. Local Sections, Tulsa, Oklahoma, December 1957.

No further details are available.

273. The Determination of the Thermal Conductivity of Gases and Gaseous Mixtures.

CHAIKIN, A. M. and MARKEVICH, A. M.

Zhur. Fiz. Khim. **32** 116-120 (1958). *Chem. Abstr.* **52** 12538 (1958).

A cylindrical vessel is used having a special heater along its axis. This arrangement ensures that the gas does not come into contact with a heated metallic surface, and the determination is based on heat flow measurement and the increase in temperature inside the vessel.

274. Vapour-Phase Chromatographic Analysis of Hydrocarbon Mixtures.

CHALKLEY, D. E.

Presented at Symposium on Gas Chromatography at Stevenston, Scotland, May 1955. Abstract in Anal. Chem. **27** (10) 1667 (1955).

Examples are given of the use of gas chromatography for the analysis of hydrocarbons both in the laboratory and for process stream monitoring.

The relative retention volumes of the C_1 - C_4 hydrocarbons on a large number of stationary phases have been recorded, and quantitative aspects of their determination have been investigated using hydrogen as carrier gas with thermal conductivity detection. Results have been compared with those obtained using mass spectrometric methods. See also reference 31.

275. The Chromathermographic Separation of Dissolved Substances.

CHARIN (or KHARIN), A. N., PROTASOV, P. N. and VOITKO, L. M. *Doklady Akad. Nauk. S.S.S.R.* **80** 611-614 (1953). *Chem. Abstr.* **51** 7220 (1957).

The chromathermographic method, which was originally developed for the separation of gases, can be applied to the analysis of an aqueous solution of acetic acid and to the separation of acetic and butyric acids.

276. The Separation of Isotopes by Chromatography and Electrophoresis.

CHEMLA, M.

J. Chromatog. **1** (1) 2-23 (1958). *Chem. Abstr.* **52** 9791 (1958).

In French. Essentially a review with 45 references, containing a section on the separation of the isotopes of neon and hydrogen by gas-adsorption chromatography.

277. Chromatothermographic Method of Determining Benzene, Toluene, *iso*-Pentane, Hexane and *iso*-Octane.

CHEMODANOVA, L. S. and TURKEL'TAUB, N. M.

Zavodskaya Lab. **22** (12) 1406-1407 (1956). *Chem. Abstr.* **51** 17610 (1957).

The hydrocarbons are adsorbed on a column of silica gel, and then determined at 160°C using air at a flow rate of 115 ml/min as carrier gas.

278. Analysis of C_5 - C_6 Saturated Hydrocarbons by Gas-Liquid Chromatography.

CHENG, L-P. and HSU, Y-S.

K'o Hsueh T'ung Pao No. 3 89-90 (1958). *Chem. Abstr.* **52** 18092 (1958).

The hydrocarbons are separated on a column packed with benzophenone on diatomaceous earth at 52°C, using hydrogen as carrier gas.

279. Gas-Liquid Chromatography: Effect of Support Size and Proportion of Liquid Phase on Column Efficiency.

CHESHIRE, J. D. and SCOTT, R. P. W.

J. Inst. Petrol. **44** 74-79 (1958). *Chem. Abstr.* **52** 8681 (1958).

The highest column efficiency commensurate with a reasonable inlet pressure is given by a support having a particle size of 100-120 B.S. mesh. Using a 25 ft $\times$ 3.6 mm diameter column packed with 5% Apiezon oil on C22 firebrick (60-100 B.S. mesh), a value of 10,000-12,000 theoretical plates may be obtained if the sample charge does not exceed 0.4 mg and the detector used has the required sensitivity.

280. New Sampling Device for Chromatographic Analysis.

CHMUTOV, K. V. and AVGUL, V. T.

Zhur. Fiz. Khim. **31** 724-725 (1957). *Chem. Abstr.* **52** 4 (1958).

A sampling device which has no rotating parts is described for use with liquids.

281. A Hydrodynamic Model of a Sorption Column.

CHMUTOV, K. V. and FILATOVA, N. V.

Gas Chromatography 1958. *Amsterdam Symposium, May 1958.*

Ed. DESTY, D. H. Published by Butterworths 1958. 99-105. Discussion 105-106.

The proposed model illustrates the principal cases of the formation of chromatograms under different kinetic and hydrodynamic conditions. A suggestion is made as to the possibility of semiquantitative modelling of the more complex cases of joint dynamic adsorption of several substances.

282. Chromatography in the Gaseous Phase.

CHOVIN, P.

Bull. Soc. chim. France 1957 83-101. *Chem. Abstr.* **51** 6273 (1957).

A review with 62 references.

283. Efficiency of Gas Chromatographic Columns.

CHOVIN, P.

Bull. Soc. chim. France **7** 905-910 (1958). *Chem. Abstr.* **52** 19405 (1958).

The theory of gas chromatographic separation is reviewed, and effects of variation in column and support size, and mass, pressure and flow rate of carrier gas are explained by means of the equation developed by van Deemter, Zuiderweg and Klinkenberg. Variations in temperature, substrate concentration and selectivity are also discussed.

284. Gas-Phase Chromatography.

CHOVIN, P.

Parfums, cosmet, savons. 1958 (7) 261-269. *Chem. Abstr.* **52** 17623 (1958).

A review which includes applications to the cosmetic industry. 25 references are given.

285. Studies on Adsorption and Adsorption Analysis with Special Reference to Homologous Series.

CLAESSON, S.

Ark. Kemi. Min. Geol. **23A** (1) 1-133 (1946). *Chem. Abstr.* **40** 3665 (1946).

The article contains sections on general discussion and applications, description of apparatus and adsorbents for both solutions and gases. Adsorbents for gases were Carboraffin I₃, Supercarbon IV-I₃, activated carbon granular I₃, and gas adsorption charcoal I₃. The theory of the methods is discussed and results of experiments with both solutions and gases are described. Some work is mentioned on the separation of Arcton 6 and Arcton 3 using a column of carboraffin and ethyl formate. Attempts to apply adsorption to the qualitative and quantitative analysis of gases and vapours have been described. Most analyses have been carried out as frontal analysis without correction for any displacement effect. Thermal conductivity or R.I. was usually used for the determination of concentrations. Desorption was also used, but the method was not selective and not quantitative. Methods are not described for hydrocarbons with more than 4 carbon atoms.

286. Frontal Analysis and Displacement Development in Chromatography.

CLAESSON, S.

Ann. N.Y. Acad. Sci. **49** 183-203 (1948). *Chem. Abstr.* **42** 5300 (1948).

Essentially a review of a more extensive paper—see previous reference.

287. Theory of Frontal Analysis and Displacement Development.

CLAESSON, S.

Discussions Faraday Soc. 1949 No. 7 34-38. *Chem. Abstr.* **44** 9769 (1950).

Essentially the same subject matter as in the 2 preceding references.

288. Partition Chromatography of a Homologous Series of Volatile Primary Amines.

CLAYTON, R. A. and STRONG, R. M.

Anal. Chem. **26** (3) 579-580 (1954). *Chem. Abstr.* **48** 7480 (1954).The normal primary amines C_3 - C_7 and 1-methylheptylamine were separated on a Celite 545/MeOH/water column, using petroleum ether as mobile phase. Typical multicomponent elution diagrams resulted.**289. Analysis of Gaseous Mixtures with a New Unit.**

CLOUGH, K. H.

Petrol. Engr. **27** (10) C26-C31 (1955). *Chem. Abstr.* **49** 14574 (1955).

Describes the 'FRACTON', an apparatus for adsorption chromatography. Adsorption is on charcoal, the carrier gas is nitrogen, and detection is by thermal conductivity. A full description of the apparatus and its operation is given.

290. Operating your Gas Chromatographic Unit.

CLOUGH, K. H.

Presented at 21st Meeting of Gulf Coast Spectroscopic Group, Baton Rouge, Louisiana, September 1956. An Abstract is given in Anal. Chem. **29** (1) 166 (1957).

The paper included a discussion of displacement and elution analysis, and a preprint of the paper contained a bibliography of 144 references.

291. High Temperature Gas Chromatography.

CLOUGH, K. H.

Presented at Southwest Regional Meeting, A.C.S. Local Sections, Tulsa, Oklahoma, December 1957.

No further details are available.

292. Fuel Gas Analysis.

COATES, V. J.

Anal. Chem. **28** (9) 40A (1956).

Part of a Perkin-Elmer Corporation advertisement probably similar to the following 2 references.

293. Fuel Gas Analysis by Vapour Fractometry (Gas Chromatography).

COATES, V. J. and BRENNER, N.

Presented at Chem. Eng. & Manuf. Gas Prod. Conf. of Am. Gas Assn. Philadelphia, May 1956.

Uses a column of silica gel 1 m long with argon as carrier gas at 25°C. Compares diagrams of the analysis of an unknown coke oven gas with that from a calibration standard mixture of hydrogen, nitrogen, carbon monoxide and methane.

294. Fuel Gas Analysis by Chromatography.

COATES, V. J. and BRENNER, N.

Petrol Refiner **35** (11) 197-201 (1956). *Chem. Abstr.* **51** 1587 (1957).

The analysis of natural, manufactured and coke oven gases may be conveniently carried out by gas chromatography.

295. Multistage Gas Chromatography Instrumentation for the Analysis of Complex Mixtures.

COATES, V. J., BRENNER, N., O'BRIEN, L. and MARCUS, N.

Presented at 133rd Natl. Meeting Am. Chem. Soc. San Francisco, April 1958. Abstract p. 49B No. 130.

A triple-stage instrument is described which simultaneously records the output of 3 column detector stages, particular detail being included on the dry valving arrangement and flow balancing system which allows series operation of the 3 columns, or independent operation of any one. The instrument has been used for the analysis of C_1 - C_7 hydrocarbons, food flavours, etc. The column effluent can also be recycled to simulate its passage through a long column.

296. Thermal Conductivity of Gases and Vapours.

CODEGONE, C.

Atti. accad. sci. Torino Classe sci. fis. mat. e nat **86** 288-290 (1951-2). *Chem. Abstr.* **48** 8606 (1954).

Gives a graphical comparison of the reduced values of conductivity coefficients with those of temperature and pressure.

297. Thermal Conductivity and Thermodynamic Properties of Gases and Vapours.

CODEGONE, C.

Termotecnica (Milan) **6** 507-511 (1952). *Chem. Abstr.* **48** 8637 (1954).

Thermal conductivity, enthalpy, energy, heat capacity and Prandtl number of several gases and organic vapours, with special emphasis on methane, are discussed in relation to the law of corresponding states, the values being expressed graphically against temperature values.

298. The Use of Vapour-Phase Chromatography in Kinetic Investigations. I. The Thermal Decomposition of Neopentyl Nitrate.

COLBURN, C. B.

Presented at 129th National A.C.S. Meeting, Dallas, Texas, April 1956. Abstract p. 20B No. 54.

The rate of the reaction between 150 and 170°C was followed by using gas chromatography. The column was Dow Corning 550 silicone fluid supported on infusorial earth, and detection was by thermal conductivity.

299. Identification of Low-Boiling Sulphur Compounds in Agha Jari Crude Oil by Gas Chromatography.

COLEMAN, H. J., THOMPSON, C. J., WARD, C. C. and RALL, H. T.

Presented at 133rd Natl. Meeting Am. Chem. Soc. San Francisco, April 1958. Abstract p. 14P No. 41.

Eleven sulphur compounds were identified in this crude oil. See next abstract.

300. Identification of Low-Boiling Sulphur Compounds in Agha Jari Crude Oil by Gas-Liquid Chromatography.

COLEMAN, H. J., THOMPSON, C. J., WARD, C. C. and RALL, H. T.

Anal. Chem. **30** (10) 1592 (1958).

The separation and identification of these compounds was accomplished on a column packed with 17% 550 silicone oil on firebrick at 38°C, using helium as carrier gas. A thermistor type thermal conductivity cell was used as detector.

- 301.** Amine oxides. V. Olefins from N,N-dimethylmenthylamine and N,N-Dimethylneomenthylamine oxides.
COPE, A. C. and ACTON, E. M.
J. Am. Chem. Soc. **80** (2) 355-359 (1958). *Chem. Abstr.* **52** 10006 (1958).
The menthenes formed were analysed by chromatography on a 200×0.6 cm column of firebrick impregnated in a 5/2 ratio with tetraethylene glycol saturated with silver nitrate. The carrier gas was helium and detection was by thermal conductivity.
- 302.** Amine Oxides. IV. Alicyclic Olefins from Amine Oxides and Quaternary Ammonium Hydroxides.
COPE, A. C., BUMGARDNER, C. L. and SCHWEIZER, E. E.
J. Am. Chem. Soc. **79** (17) 4729-4733 (1957). *Chem. Abstr.* **52** 2771 (1958).
Olefins were analysed by gas chromatography using a 183×0.8 cm column packed with 40% of a saturated silver nitrate in diethylene glycol solution on Celite 545, using helium as carrier gas and thermal conductivity detection.
- 303.** Amine Oxides. III. Selective Formation of Olefins from Unsymmetrical Amine Oxides and Quaternary Ammonium Hydroxides.
COPE, A. C., LEBEL, N. A., LEE, H-H. and MOORE, W. R.
J. Am. Chem. Soc. **79** (17) 4720-4729 (1957). *Chem. Abstr.* **52** 2769 (1958).
Olefins were separated on a column (183×0.3 cm) packed with 30% carbethoxydimethylformamide on Celite 545. A mixture of 1-butene and *cis*- and *trans*-2-butene were analysed on a column of 30% dimethylformamide on Celite 545 and cooled to -30°C . A mixture of *cis*- and *trans*-2-pentene was separated on silver nitrate in diethylene glycol. In all cases helium was used as carrier gas with thermal conductivity detection.
- 304.** Fractometric Determination of Methane.
COPPENS, L., BRICTEAUX, J. and VENTER, J.
Bull. Tech. Houille, Liege, 1958 (13) 426-446. *Anal. Abstr.* **5** 3774 (1958).
Describes the application of gas chromatography to adsorption methods under Linde 5A molecular sieve for methane in methane/air mixtures.
- 305.** Notes on Gas Chromatography.
COPPENS, L., VENTER, J. and BRICTEAUX, J.
Inst. natl. ind. charbonnière, Bull. tech-Houille et dérivés. 1956. 311-334. *Chem. Abstr.* **51** 5386 (1957).
A review giving 27 references.
- 306.** Developments in Gas Chromatography.
CORBIN, J. R.
Proc. 35th Annual Convention, Natural Gasoline Assn. of America, 1956. 37-40.
A general article on the development of apparatus for gas chromatography with some notes on the identification of peaks.
- 307.** Developments in Chromatography.
CORBIN, J. R.
Proc. 31st Annual Meeting California Nat. Gas. Assoc. November 1956. 3-5.
Description of a gas chromatography unit having a capillary liquid sampler and a fraction collecting system.

308. Gas Chromatography—New Developments.

CORBIN, J. R.

Proc. 31st Annual Meeting, California Nat. Gas Assoc. Los Angeles, November 1956. Reported in Oil Gas J. 54 (85) 127-128 (1956).

See the previous 2 references.

309. The Qualitative and Quantitative Analysis of Multicomponent Mixtures by Vapour Fractometry.

CORBIN, J. R. and COATES, V. J.

Presented at Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, February 1956.

The Perkin-Elmer instrument for gas-phase chromatography was described and some examples of its application were given.

310. Separation of Volatile Organic Compounds by Vapour-Phase Chromatography.

CORDON, J. L. M. and LOPEZ, G. Z.

Combustibles (Zaragoza) 16 65-75 (1956). J. Inst. Petrol. Abstr. No. 1566 (1956).

The use of activated carbon or dioctylphthalate on Kieselguhr as column packings in a simple apparatus is described. Thermal conductivity detection was employed. The apparatus was used for the separation of *cis*- and *trans*-dichloroethylene, aliphatic halogen derivatives, alcohols and esters, aromatic hydrocarbons and a petroleum fraction.

311. Structure of a Naturally Occurring Antagonist of Dihydrostreptomycin.

CORNFORTH, J. W. and JAMES, A. T.

Biochem. J. 63 124-130 (1956). Chem. Abstr. 50 12169 (1956).

A chemical examination has been made of a crystalline product from *Pseudomonas pyrocyanea* which antagonises the antibacterial action of dihydrostreptomycin.

312. A New Technique for Adsorption Studies.

COULL, J., ENGEL, H. C. and MILLER, J.

Ind. Eng. Chem., Anal. Ed. 14 459-462 (1942). Chem. Abstr. 31 4747 (1942).

Mixtures of air with various solvents (benzene, chloroform, carbon tetrachloride) were used to study the adsorptive properties of activated carbons. A thermal conductivity cell was used to determine the composition of these vapour mixtures, and calibration curves were prepared.

313. The Selection and Operation of Thermistors for Katharometers.

COWAN, C. B. and STIRLING, P. H.

Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.

Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 165-190.

This paper lists the properties which a thermal element should have and discusses these. A very full description of thermistors and their properties is given as a guide to the choice of such elements as detectors.

314. The Determination of Steroid Side-chains.

COX, J. S. G., HIGH, L. B. and JONES, E. R. H.

Proc. Chem. Soc. 1958 234-235. Chem. Abstr. 53 6292 (1959).

The products of pyrolysis were analysed by gas chromatography on a column of Apiezon L on firebrick at 100°C, and a flame ionisation detector was used.

315. The Katharometer in Gas Analysis.

COXON, R. V., BANISTER, P. G. and KAY, R. H.

Rec. trav. chim. **74** (5) 513-517 (1955). *Chem. Abstr.* **49** 16034 (1955).

In English. a katharometric device has been applied to the problem of securing continuous records of the atmospheric conditions inside incubators during oxygen administration.

316. Application of Vapour-Phase Chromatography in the Gas-Analytical Field.

CRAATS, F. van de.

Anal. Chim. Acta **14** (2) 136-149 (1956). *Chem. Abstr.* **51** 949 (1957).

In English. The general principles of gas chromatography are discussed, particularly in relation to the separation of lower hydrocarbons. If only 1 component in a mixture is to be determined or if the number of components is small, continuous thermal conductivity detection may be employed. If the number of components is large, the carbon dioxide carrier gas may be absorbed, and the separated components passed to an evacuated receiver in which the pressure rise may be recorded automatically.

317. Some Quantitative Aspects of the Chromatographic Analysis of Gas Mixtures, using Thermal Conductivity as Detection Method.

CRAATS, F. van de.

Gas Chromatography 1958. *Amsterdam Symposium—May* 1958.*Ed. DESTY, D. H. Published by Butterworths* 1958. 248-261. *Discussion* 261-264.

Calibration for gas mixtures by using pure individual components requires a detector giving a linear relationship between the signal and the concentration of the components in the carrier gas. This property has been extensively investigated for a number of thermal conductivity detectors, and it has been found that with hydrogen or helium as carrier gas, a satisfactory linearity can be realised.

318. Chromatographic Separation and Determination of Gases.

CREMER, E.

Chem.-Ing. Tech. **28** (12) 805 (1956).

In German. A brief review of a paper on the use of gas chromatography for the separation of gases. Some further remarks by H. H. Hausdorff are appended.

319. Gas Chromatography of Very Small Quantities (Microgram Range).

CREMER, E. and HAUPT, R.

Angew. Chem. **70** 310-311 (1958). *Chem. Abstr.* **52** 16115 (1958).

The complete separation of the components of a mixture in the microgram range is unnecessary. Results may be calculated using a calibration curve and from direct proportionality of quantity and peak height.

320. Separation and Quantitative Determination of Small Quantities of Mixed Gases by Chromatography.

CREMER, E. and MULLER, R.

Mikrochim. Acta **36/37** 553-560 (1951). *Chem. Abstr.* **45** 5057 (1951).

An equation is derived for the migration velocity of zones in chromatographic analysis, and it is demonstrated that a characteristic quantity of energy can be calculated from every 2 migration rates. Separations of hydrocarbons (C_2H_4, C_2H_2), nitrogen and carbon dioxide were made on either silica gel or activated carbon using hydrogen as carrier gas.

321. Separation and Determination of Substances by means of Gas-Phase Chromatography.

CREMER, E. and MULLER, R.

Z. Elektrochem. **55** (3) 217-220 (1951). *Chem. Abstr.* **45** 9335 (1951).

Mixtures of acetylene/ethylene, carbon dioxide/acetylene, and ethylene/propylene were completely resolved by the method described in the following reference. Observation of the breakthrough time characteristic of any substance, makes possible its detection without complete separation, but this can only be done if the breakthrough time is independent of concentration.

322. Application of Chromatographic Methods to the Separation of Gases and to the Determination of Adsorption Energies.

CREMER, E. and PRIOR, F.

Z. Elektrochem. **55** (1) 66-70 (1951). *Chem. Abstr.* **45** 9334 (1951).

Using hydrogen as carrier gas, the passage of gaseous compounds through columns of activated carbon and silica gel was investigated in relation to temperature, concentration and flow rate, with a thermal conductivity detector. The separation of an ethylene/acetylene mixture is fully described.

323. Gas Chromatography: A Review.

CREMER, E. and ROSELIUS, L.

Z. Angew. Chem. **70** (2) 42-49 (1958). *Anal. Abstr.* **5** 3597 (1958).

A review of theory and practice in which the theoretical treatment is considered from both the kinetic and statistical thermodynamic standpoints. The determination of heats of adsorption of gases, and the water content of adsorbents, are applications of this technique which are discussed particularly.

324. Analysers Unlock Process Control.

CRONAN, C. S.

Chem. Eng. **63** (12) 252-260 (1956).

Describes 2 explosion-proof process chromatographs and a sample vapour-iser regulator.

325. Analytical Separation of the Methyl Esters of the C₁₂-C₂₂ Fatty Acids by Vapour-Phase Chromatography.

CROPPER, F. R. and HEYWOOD, A.

Nature **172** (4389) 1101-1102 (1953). *Chem. Abstr.* **48** 3203 (1954).

Separation of these esters is possible at 230°C using a column packed with Celite and an equal amount of Dow Corning High Vacuum Silicone grease ground together and thoroughly mixed. Nitrogen is used as carrier gas, and detection is by 2 platinum wire katharometers which are connected to a Wheatstone bridge arrangement and a Cambridge high speed recorder.

326. Improvements in Vapour-Phase Chromatography at Relatively High Temperatures.

CROPPER, F. R. and HEYWOOD, A.

Nature **174** (4440) 1063-1064 (1954). *Chem. Abstr.* **49** 5197 (1955).

The substances investigated were fatty-acid esters and fatty alcohols, using a column packing of Celite 545 (60%) and 40% ethyl acetate-washed silicone grease. The thermal decomposition of hexadecanol/octadecanol mixtures and brominated technical methyl oleates at 265°C produced

charred products which clogged the column. To overcome this, sodium chloride crystals replaced the Celite. (NaCl 95%, acetate-washed grease ca 5%.) Straight wire katharometers were replaced by coiled platinum wire in a small glass envelope and the sensitivity was increased 5 times.

327. The Analysis of Fatty Acids and Fatty Alcohols by Vapour-Phase Chromatography.

CROPPER, F. R. and HEYWOOD, A.

I.P. Symposium, London, 1956. 316-331.

Ed. DESTY, D. H. Published by Butterworths 1957.

The range of vapour-phase chromatographic analysis was extended to temperatures up to 300°C, and the apparatus has been used for the analysis of the methyl esters of straight chain fatty acids from C₆-C₂₂ and for fatty alcohols from C₁₀-C₁₈. See the previous 2 references.

328. The Metabolism of *Leishmania Donovanii* in culture.

CROWTHER, S., FULTON, J. D. and JOYNER, L. P.

Biochem. J. **56** 182-185 (1954). *Chem. Abstr.* **48** 5926 (1954).

The analysis by gas chromatography of the volatile fatty acids in metabolic products showed that only acetic acid was formed in significant amounts, with no formic and only traces of propionic, pyruvic and succinic acids.

329. Clarifying Efficiency of Diatomaceous Filter Aids.

CUMMINS, A. B.

Ind. Eng. Chem. **34** 403-411 (1942). *Chem. Abstr.* **36** 2450 (1942).

The general properties of commercial Celite filter aids are given, and data are included for Celite 503, 535 and 545.

330. Synthesis of Cyclohexadienones.

CURTIN, D. Y. and FRASER, R. R.

Chem. and Ind. (London) 1957 (41) 1358. *Chem. Abstr.* **52** 7165 (1958).

Describes the use of gas chromatography to test the purity of the synthesised product.

331. 1:1-Dihalocyclohexanes.

CUTHBERTSON, F. and MUSGRAVE, W. K. R.

J. Appl. Chem. (London) **7** (2) 99-104 (1957). *Chem. Abstr.* **51** 12834 (1957).

The products of reaction were separated by gas chromatography on a 1 in. diameter glass column packed with Edwards 8A vacuum oil on Celite 545. Nitrogen was used as carrier gas with thermal conductivity detection.

332. Molecular Rearrangements in the Reactions of Oxygen Atoms with Olefins.

CVETANOVIC, R. J.

Can. J. Chem. **36** (4) 623-634 (1958). *Chem. Abstr.* **52** 15415 (1958).

Reactions of oxygen atoms with propene, 1-butene, isobutene, *cis*- and *trans*-2-butene, and *cis*-2-pentene were studied. Gas chromatography was used to estimate the reaction products. The column was packed with glass spheres (passing 270 mesh) supporting dinonyl phthalate.

- 333.** Micro Vapour-Phase Chromatography—Effect of Column Temperature. CVETANOVIC, R. J. and KUTSCHKE, K. O.

I.P. Symposium, London, 1956. 87.

Ed. DESTY, D. H. Published by Butterworths 1957.

For the application of gas chromatography to the qualitative microanalysis of the complex mixtures of products encountered in kinetic studies, it is suggested that relative, rather than absolute elution times are a more reliable criterion for the characterisation of a compound. Elution times of a number of compounds are correlated as functions of temperature, and the effects of changes in some other column parameters have been investigated.

- 334.** The Analysis of Cyclopentadiene-containing Products, with Particular Reference to Gas Chromatography.

DAHMEN, E. A. M. F. and LAARSE, J. D. van der.

Presented at meeting on 'The analysis of gaseous and liquid hydrocarbons and their derivatives by physical methods'. Essen, January 1958. Printed in Z. Anal. Chem. 164 (1) 37-48 (1958).

In German. The impurities, dimers and codimers present in cyclopentadiene were separated on a column containing polyethylene glycol 400, enabling the processes of polymerisation and depolymerisation to be studied.

- 335.** Redetermination of the Krypton and Xenon Contents of Atmospheric Air.

DAMKOHLER, G.

Z. Elektrochem. 41 74-80 (1935). Chem. Abstr. 29 2796 (1935).

The krypton and xenon distilled from atmospheric air were adsorbed on charcoal and purified. The degree of purification was checked by an interferometer test.

- 336.** Investigations of Reactions along the Catalyst Bed in Flow Systems by Vapour-Phase Chromatography. Part I. Decomposition of Methanol on a Cobalt Fischer-Tropsch Catalyst.

DARBY, P. W. and KEMBALL, C.

Trans. Faraday Soc. 53 (6) 832-840 (1957). Chem. Abstr. 52 7121 (1958).

It is shown that sampling combined with analysis by vapour-phase chromatography is an informative technique for investigation of catalytic reactions in a flow system. The decomposition of methanol to carbon monoxide and hydrogen at 163-210°C was studied over a Cobalt Fischer-Tropsch catalyst.

- 337.** Experimental Thermal Conductivities of Gases and Gaseous Mixtures at Zero Degrees Centigrade.

DAVIDSON, J. M. and MUSIC, J. F.

U.S. Atomic Energy Commission, Tech. Information Service HW-29021. 7-30 (1953). Chem. Abstr. 48 5581 (1954).

The thermal conductivities at 0°C of carbon dioxide, helium, neon, nitrogen, and their binary mixtures are given, and the method of determination is described.

- 338.** A Thermal Conductivity Detector for use at High Temperatures in Vapour-Phase Chromatography.

DAVIES, A. J. and JOHNSON, J. K.

I.P. Symposium, London, 1956. 185.

Ed. DESTY, D. H. Published by Butterworths 1957.

Difficulties involved in widening the scope of the method are described and

discussed. Methods of surmounting these difficulties, exemplified in an instrument capable of reliable operation at 300-350°C are described with reference to testing and performance.

339. Modern Analytical Chemistry in Industry.

DAVIES, G. R.

Nature **180** (4582) 366 (1957). *A report of the Soc. for Anal. Chem. Congr. at St. Andrews, Scotland, June 1957.*

Abstracts of relevant papers are given under the Authors' names.

340. The Use of Thermistor Detectors in Gas Chromatography.

DAVIS, A. D. and HOWARD, G. A.

Chem. and Ind. (London) B.I.F. Review 1956 R25-R26. *Chem. Abstr.* **50** 15135 (1956).

Describes the use of a thermistor as a detector at temperatures up to 170°C. See following reference.

341. Thermistor Detectors in Gas Chromatography.

DAVIS, A. D. and HOWARD, G. A.

J. Appl. Chem. (London) **8** (3) 183-186 (1958). *Chem. Abstr.* **52** 12464 (1958).

Details are given of an instrument using a thermistor detector. The conditions to be observed and the necessary precautions to be taken during use are enumerated.

342. Liquid Sample Inlet System for Gas Chromatographs.

DAVIS, R. E. and McCREA, J. M.

Anal. Chem. **29** (7) 1114-1115 (1957). *Chem. Abstr.* **51** 13473 (1957).

A mass spectrometer inlet system has been adapted for use with a gas chromatograph. A full description, with a diagram, of its construction and use is given.

343. Double Column Gas Chromatography: Analysis of Noncondensable and Light Hydrocarbon Gases by a Combined Gas-Liquid, Gas-Solid Chromatograph.

DAVIS, R. E. and SCHREIBER, R. A.

Advances in Gas Chromatography, A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D-91 to D-95. Presented during 132nd Meeting, A.C.S.

An apparatus is described which permits the separation of wide boiling range mixtures. Unresolved eluent from the first column is resolved on the second, and each column has a separate detector and recorder. A description is given of the application of such an apparatus to the resolution of a 17 component mixture, containing all C₁ through C₄ paraffins and olefins.

344. Formation and Reactions of Free Radicals of Hydrocarbons in the Gas-Phase through Irradiation at High Energy.

DAVISON, W. H. T.

Presented at Meeting of Chem. Soc. Cambridge, England, April 1957. Reported in Angew. Chem. **69** (13/14) 491 (1957).

Propane and ethane were bombarded with 2 MeV electrons and gamma rays from Cobalt 60, and the products analysed by gas chromatography.

345. A Novel Method of Identification of Polymers.

DAVISON, W. H. T., SLANEY, S. and WRAGG, A. L.

Chem. and Ind. (London) 1954 (44) 1356. *Chem. Abstr.* **49** 3736 (1955).

There is a growing need in industry for a general method of identification of polymers. At present the most general method is i.r. which may be combined with pyrolysis. An alternative approach is to subject the pyrolysates to gas-partition chromatography and use the pattern of peaks on the recorded chromatogram as a method of identification. It is not necessary to identify the individual components, but merely recognise the pattern obtained. The method is:—The polymer is pyrolysed at 650°C in a stream of nitrogen at atmospheric pressure and the products condensed. A fraction boiling below about 100°C is chromatographed in an apparatus similar to that of Ray using a 6 ft column packed with Celite/dinonyl phthalate at 111°C (toluene vapour). It is also intended to scale down the method using a semi-micro pyrolysis apparatus.

346. Applications of Vapour-Phase Partition Chromatography to the Analysis of Catalytic Reformates.

DAWSON, H. J. and SCHMAUCH, L. J.

Presented at 129th National A.C.S. Meeting, Dallas, Texas, April 1956. Abstracts p. 17B No. 46.

C₃-C₅ paraffins are analysed on a column (4 mm × 4 ft) with 1-octadecene as stationary phase and 2-methyl-2-butene as internal standard at room temperature. The products from the reforming of pure hydrocarbons are resolved on a similar column with dinonyl phthalate as stationary phase and *n*-octane as internal standard, at 78°C. In both cases nitrogen is used as carrier gas and a novel thermal conductivity cell as detector.

347. Applications of Vapour-Phase Partition Chromatography to the Analysis of Catalytic Reformates.

DAWSON, H. J. and SCHMAUCH, L. J.

Presented at Conf. on Anal. Chem. and Appl. Spectroscopy, Pittsburgh, 1956.

See previous reference.

348. Flavour and Odour Defects of Gamma-Irradiated Skimmed Milk. II. Identification of Volatile Components by Gas Chromatography and Mass Spectrometry.

DAY, E. A., FORSS, D. A. and PATTON, S.

J. Dairy Sci. **40** 932-941 (1957). *Chem. Abstr.* **51** 18366 (1957).

The volatile components were separated on a column of Carbowax 400 on firebrick, and identified by mass spectrometry. Methyl sulphide, acetaldehyde, acetone, butanone, methanol and ethanol were identified, but it is considered that only the first 2 were of odour significance.

349. Gas Analysis by Measurement of Thermal Conductivity.

DAYNES, H. A.

*Published by Cambridge Univ. Press, London, 1933. 357 pp.*A review of this book appears in *Gas J.* **202** 613 (1933).

350. Gas-Liquid Partition Chromatography.

DEAL, C. H.

Presented at Symposium on Recent Developments in Research Methods and Instrumentation, Bethesda, Maryland, May 1956. Abstract in Anal. Chem. **28** (6) 1058 (1956).

A general description of the operation of a gas chromatographic column, giving the principles affecting the separation of the components of mixtures. Important effects were illustrated by chromatograms.

351. A Radiological Detector for Gas-Liquid Partition Chromatography.

DEAL, C. H., OTVOS, J. W., SMITH, V. N. and ZUCCO, P. S.

Presented at 129th National A.C.S. Meeting, Dallas, Texas, April 1956. Abstracts p. 16B. No. 42.

Describes the development of a detector which exploits differences in β -ionisation cross sections. The detector is insensitive to flow rate, and has a rapid response, high stability and sensitivity, and may be applied over a wide field. The method of use and its application in gas chromatographic analysis is described.

352. A Radiological Detector for Gas Chromatography.

DEAL, C. H., OTVOS, J. W., SMITH, V. N. and ZUCCO, P. S.

Anal. Chem. **28** (12) 1958-1964 (1956). *Chem. Abstr.* **51** 2335 (1957).

A method for sensing changes in the composition of a gas stream has been developed which exploits differences in β -ionisation cross sections and is suitable for gas chromatography. It gives a detector instrument of very rapid response, high stability, high sensitivity and broad applicability, which is insensitive to gas flow rate. Fundamental principles are outlined and the apparatus and its application to gas chromatography are described.

353. Ion Identification in Flames by Mass Spectrometry.

DECKERS, J. and TIGGELEN, A. van.

Nature **181** 1460 (1958). *Chem. Abstr.* **52** 19311 (1958).

The peaks observed on a mass spectrometer on burning a mixture of nitrogen, acetylene and oxygen are listed and described.

354. Theory and Experiment.

DEEMTER, J. J. van.

Gas Chromatography 1958. Amsterdam Symposium—May 1958.

Ed. DESTY, D. H. Published by Butterworths 1958. 3-5.

A short review of some aspects of theory in relation to the possibilities of the chromatographic column, both as a separation medium and a means of providing thermodynamic data.

355. Longitudinal Diffusion and Resistance to Mass Transfer as Causes of Nonideality in Chromatography.

DEEMTER, J. J. van, ZUIDERWEG, F. J. and KLINKENBERG, A.

Chem. Eng. Sci. **5** (6) 271-289 (1956). *Chem. Abstr.* **51** 801 (1957).

The mechanisms of band broadening in linear, nonideal chromatography are examined, and the development of a rate theory for this process is presented.

- 356.** Rapid Gas Analyser using Ionisation by Alpha Particles.
DEISLER, P. F., McHENRY, K. W. and WILHELM, R. H.
Anal. Chem. **27** (9) 1366-1374 (1955). *Chem. Abstr.* **50** 4 (1956).
A method and apparatus are presented for the analysis of a flowing or quiescent gaseous mixture. The ionisation current obtained depends for its precise value on the composition of the gas. Primary calibration is necessary and must be repeated at intervals.
- 357.** Better Absorber Control, Higher Recovery and More Profits.
DENNY, B.
Petrol. Engr. **30** (5) C17-C18 (1958). *Chem. Abstr.* **52** 11396 (1958).
The economics of the use of gas chromatography for process control monitoring in a gasoline plant.
- 358.** Chromatograph Has a Quick Payout at Snyder Plant.
DENNY, B.
Oil Gas J. **56** (16) 117-118 (1958). *Chem. Abstr.* **52** 15883 (1958).
Describes the use of gas chromatography in the continuous analysis of a propane gas stream from a depropaniser. This technique makes it possible to adjust the operation so that the propane contains a minimum of *iso*-butane.
- 359.** Application of Physical Methods of Analysis in the Gas Industry.
DENSAM, A. B. and GOUGH, G.
Gas World **146** (3805) 118-121 (1957). *Chem. Abstr.* **52** 3309 (1958).
A review of methods including i.r., u.v., spectroscopy, and gas chromatography. See following reference.
- 360.** The Application of Physical Methods of Analysis in the Gas Industry.
DENSAM, A. B. and GOUGH, G.
Proc. Congr. Modern Anal. Chem. in Industry, June 1957. Published by Heffers 1958. 56.
Includes a small section on the gas chromatographic analysis of benzoles, coal tar naphthas, and gas analysis by Janak's method.
- 361.** Crystal Structure of Chabazite, a Molecular Sieve.
DENT, L. S. and SMITH, J. V.
Nature **181** (4626) 1794-1796 (1958). *Chem. Abstr.* **52** 19735 (1958).
A new structure has been determined using Fourier methods, and this explains the X-ray intensities and sorption of the mineral.
- 362.** Separation, by Chromatographic Adsorption, of Higher Alkylaryl Hydrocarbons in Reaction Mixtures.
DESPA, S., IFTIMESCU, C. and RHOE, A.
Lucparile inst. petrol si gaze, Bucuresti **3** 219-238 (1957). *Chem. Abstr.* **52** 21023 (1958).
Attempts to separate mixtures containing octadecane, octadecene, butyl naphthalenes etc. on a silica gel column are reported. The effectiveness of the separation obtained is a function of the alkane : alkene ratio in the mixture.

363. Gas Chromatography.

DESTY, D. H.

Nature **179** (4553) 241-242 (1957).

Recommendations of a special committee on nomenclature, including: Definition of gas chromatography, how to present retention volumes, how to present column resolution, and a description of vapour detectors.

364. Vapour Detectors for Gas Chromatography.

DESTY, D. H.

Nature **180** (4575) 22-23 (1957).

A report on an informal symposium held at Oxford, May 1957.

365. Column Packings for Gas Chromatography.

DESTY, D. H.

Nature **181** (4609) 604 (1958).

A brief account of an informal symposium held at Cambridge, October 1957.

366. Gas Chromatography.

DESTY, D. H.

A lecture to Roy. Inst. Chem. and Inst. Petroleum, Morecambe, September 1958. Reported in J. Roy. Inst. Chem. **82** 736-737 (1958).

Describes the use of this comparatively new technique in the analysis of liquid and gaseous petroleum products. Janak's method was also described, together with modern detectors and capillary columns.

367. Evaluation of a Commercial Alkylarylsulphonate Detergent as a Column Packing for Gas Chromatography.

DESTY, D. H. and HARBOURN, C. L. A.

Advances in Gas Chromatography, A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D-157 to D-169. Presented during 132nd Meeting A.C.S.

Commercial household detergents of above type provide an excellent general purpose packing, but are very hygroscopic. The active agent is stable at high temperatures, but its ill-defined composition and varying concentration in detergents make it unsuitable as a standard packing. The material has been fully investigated and its behaviour is described.

368. The Application of Vapour-Phase Chromatography to the Analysis of Liquid Petroleum Fractions.

DESTY, D. H. and WHYMAN, B. H. F.

Presented at Group Session on Anal. Research, 21st Midyear Meeting, Division of Refining, Am. Petroleum Inst. Montreal, Canada, May 1956.

See following 2 references.

369. Application of Vapour-Phase Chromatography to the Analysis of Liquid Petroleum Fractions.

DESTY, D. H. and WHYMAN, B. H. F.

Anal. Chem. **28** (5) 919 (1956).

An abstract only of a paper presented at the Meeting listed in the previous reference. See also the following reference.

370. Application of Gas-Liquid Chromatography to Analysis of Liquid Petroleum Fractions.

DESTY, D. H. and WHYMAN, B. H. F.

Anal. Chem. **29** (3) 320-329 (1957). *Chem. Abstr.* **51** 9135 (1957).

A gas density balance apparatus has been used to determine the retention volumes of 88 hydrocarbons and some sulphur compounds boiling between 30 and 150°C. The stationary phase liquids used were *n*-hexatriacontane and benzyldiphenyl supported on Celite 545. The carrier gas was 'oxygen-free' nitrogen containing less than 10 ppm of oxygen.

371. The Application of Vapour-Phase Chromatography to the Examination of Samples Taken from Internal Combustion Engines by the Open-Hole Technique.

DESTY, D. H., WARHAM, T. J. and WHYMAN, B. H. F.

I.P. Symposium, London, 1956. 346.

Ed. DESTY, D. H. Published by Butterworths 1957.

Fuel quality distribution has been investigated, and vapour-phase chromatography has been used to analyse extremely small samples of unburnt fuel obtained. A possible extension of the procedures developed to other similar problems is discussed.

372. Operating Data on 2 Stationary Phase Supports.

DESTY, D. H., GODFREY, F. M. and HARBOURN, C. L. A.

Gas Chromatography 1958. Amsterdam Symposium—May 1958.

Ed. DESTY, D. H. Published by Butterworths 1958. 200-211. *Discussion* 211-215.

The operating characteristics of Celite 545 and C22 firebrick are considered in detail, and a comparison of their behaviour is given. It is concluded that from the point of view of column efficiency and pressure drop there is little to choose between these supports when used in the form of narrow mesh range fractions. Other factors may be important for particular applications.

373. The Theory of Chromatography.

DeVAULT, D.

J. Am. Chem. Soc. **65** 532-540 (1943). *Chem. Abstr.* **37** 3316 (1943).

Equations derived for simple and multiple solutes can be applied to a wide variety of conditions. A suggestion is made that the diffuse boundaries of chromatograms are likely to give more information than sharp ones.

374. Thermal Conductivity in Rarefied Gases: Accommodation Coefficient.

DEVIIENNE, F. M.

Mem. sci. Phys. Acad. Sci. Paris No. 56 1-71 (1953). *Chem. Abstr.* **48** 4910 (1954).

A review giving 136 references.

375. Some Factors Influencing the Efficiency of Gas-Liquid Chromatography Columns.

De WET, W. J. and PRETORIUS, V.

Anal. Chem. **30** (3) 325-329 (1958). *Chem. Abstr.* **52** 10793 (1958).

The effect of the following parameters was studied:—nature of the carrier gas, linear velocity of the carrier gas, column temperature, particle size of the solid support, density of column packing and the amount of liquid phase used. By varying these parameters, and using pentane and hexane on a column of liquid paraffin on Celite, it is shown that the results obtained agree with Van Deemter's theories.

376. Radiation Chemistry of *n*-Hexane and Cyclohexane Liquids.

DEWHURST, H. A.

J. Chem. Phys. **24** 1254-1255 (1956).

A preliminary note on the irradiation of the liquids, and the use of gas-liquid partition chromatography for the separation and identification of the products. No details of column packings are given.

377. Radiation Chemistry of Hydrocarbons: *n*-Alkane Liquids.

DEWHURST, H. A.

Presented at 131st National Meeting A.C.S., Miami, Florida, April 1957. Abstracts p. 7R No. 17.

By means of gas chromatographic analysis it has been shown that essentially 3-product groups are formed:—a low molecular weight group, an intermediate molecular weight group and a dimer group.

378. Radiation Chemistry of Organic Compounds. I. *n*-Alkane Liquids.

DEWHURST, H. A.

J. Phys. Chem. **61** 1466-1471 (1957). *Chem. Abstr.* **52** 3536 (1958).

The products of decomposition were examined by gas chromatography and this showed that 3 primary product groups were formed:—a dimer group, an intermediate group and a degradation group.

379. Radiation Chemistry of Organic Compounds. II. *n*-Hexane.

DEWHURST, H. A.

J. Phys. Chem. **62** 15-20 (1958). *Chem. Abstr.* **52** 7877 (1958).

The gaseous and liquid products of the radiolysis were studied by gas chromatography.

380. Radiation Chemistry of Organic Compounds. III. Branched Chain Alkanes.

DEWHURST, H. A.

J. Am. Chem. Soc. **80** (21) 5607-5610 (1958).

Gas chromatography was used to separate and determine isomeric hexanes and alkyl iodides. The stationary phase was didecyl phthalate. No further details are given.

381. Electron and Gamma-Ray Radiolysis of *n*-Hexane.

DEWHURST, H. A. and WINSLOW, E. H.

J. Chem. Phys. **26** 969-970 (1957). *Chem. Abstr.* **51** 12670 (1957).

The chromatograms obtained from the gas chromatographic analysis of the reaction products were substantially the same for both radiation sources.

382. Comparison of Different Types of Detector for Gas-Liquid Partition Chromatography.

DICKHOLTZ, R., MARKS, M. L. and HALL, L. G.

Presented at Pittsburgh Conf. on Anal. Chem. March 1958. Paper 145.

No further details are available.

383. Purification of Liquids and Low Melting Solids by Progressive Freezing.
DICKINSON, J. D. and EABORN, C.*Chem. and Ind. (London)* 1956 (36) 959. *Chem. Abstr.* **51** 3220 (1957).

Gas chromatography was used to test the purity of benzene, *p*-bromotoluene etc., purified by the method described.

- 384.** The Chromatographic Identification of Pyrazine Bases.
DIETRICH, P. and MERCIER, D.
J. Chromatog. **1** (1) 67-69 (1958). *Chem. Abstr.* **52** 9869 (1958).
In French. Describes the separation of volatile pyrazine bases by gas-liquid chromatography on a column of dinonyl phthalate at 120°C, using nitrogen as carrier gas, and also the separation by paper chromatography of pyrazine carboxylic acids.
- 385.** Bibliography of Solid Absorbents. 1943-1953.
DIETZ, V. R.
U.S. Dept. of Commerce. Nat. Bur. Stds. Circ. **566**. Issued March, 1956. 1,528 pp.
Contains 13,763 abstracts of papers dealing with all aspects of adsorption and adsorbents, both for gases and liquids, and includes complete subject and author indexes.
- 386.** Analysis of Light Ends on Saturate Naphthas, using Gas Chromatography.
DIETZ, W. A.
Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.
Ed. COATES, V. J., NOBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 87-91.
Describes an analysis carried out using a column (2 m $\times$ $\frac{1}{4}$ in. O.D.) of silicone fluid on Celite 545 or firebrick at 75°C, with helium as carrier gas and thermal conductivity detection.
- 387.** Analysis of Petroleum Fractions by Gas Chromatography.
DIETZ, W. A.
Presented at 12th Ann. Meeting, Soc. for Appl. Spectroscopy, New York, November 1957. Abstract in Appl. Spectroscopy **12** (1) 20 (1958).
The paper gives a review of the progress of gas chromatography in the analysis of petroleum, and cites typical analyses of fixed gases, gaseous hydrocarbons and hydrocarbons in the gasoline range. No experimental details are given in the abstract.
- 388.** Applications of Gas Chromatography to Petroleum Processes.
DIETZ, W. A. and DUDENBOSTEL, B. F.
Advances in Gas Chromatography—A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D171-D176. *Presented during 132nd Meeting, A.C.S.*
Describes the analysis of light ends on saturate naphthas on a column packed with silicone oil on Celite 545 at 75°C using helium as carrier gas, and also the analysis of cracked gases, ethane through pentanes, on a column of 2,5-hexanedione on C22 firebrick at 0°C with helium as carrier gas.
- 389.** The Use of Coated Capillaries as Columns for Gas Chromatography.
DIJKSTRA, G. and GOEY, J. de.
Gas Chromatography 1958. Amsterdam Symposium—May 1958.
Ed. DESTY, D. H. Published by Butterworths 1958. 56-62. *Discussion* 62-68.
An investigation into 3 types of capillary columns:— (1) Glass—15 m $\times$ 1 mm. (2) Glass—25 m $\times$ 0.5 mm. (3) Copper—120 m $\times$ 0.3 mm. A separating efficiency of 2,500 theoretical plates is obtained with (3) and the coating procedure is critical but simple.

390. Gas-Liquid Partition Chromatography.

DIJKSTRA, G., KEPPLER, J. G. and SCHOLS, J. A.

Rec. trav. chim. **74** (6) 805-812 (1955). *Chem. Abstr.* **50** 1528 (1956).

The technique is applied to the separation of aliphatic acids, esters, alcohols and aldehydes with 4-18 C atoms. The column is run at a temperature between 80 and 230°C, with stationary phases of silicone high vacuum grease/Celite (10 : 1), or paraffin wax/Celite (10 : 2), (for aldehydes only), and nitrogen is used as eluent. The presence of the material to be separated is detected by differences in thermal conductivity registered on a recorder.

391. Factors which Influence Efficiency in Gas-Liquid Partition Chromatography.

DIMBAT, M.

Presented at Southwide Chem. Conf. on Instrumentation, Instr. Soc. Am. Symposium on Gas Chromatography, Memphis, Tenn., December 1956. No further details are available.

392. Apparatus Requirements for Quantitative Application of Gas-Liquid Partition Chromatography.

DIMBAT, M., PORTER, P. E. and STROSS, F. H.

Anal. Chem. **28** (3) 290-297 (1956). *Chem. Abstr.* **50** 9204 (1956).

In this paper, features of apparatus and method are discussed which are important in reproducible analyses of this type. Features include a by-pass sample system which provides for reproducible dosage of samples of known weight, coiled Cu tube columns for convenient thermal control of long columns and a solid support (crushed firebrick) which gives better separation and is easier to pack into the columns than the commonly used Celite.

393. Vapour-Phase Chromatography—A new Method for the Separation and Identification of Volatile Materials in Foods.

DIMICK, K. P. and CORSE, J.

Proc. Conf. Appl. Phys. Sci. Food Research Process and Preserv., 1st San Antonio, Texas, 1956. 59-76. *Chem. Abstr.* **52** 593 (1958).

A review with 17 references. See following reference.

394. Gas Chromatography—A New Method for the Separation and Identification of Volatile Materials in Foods.

DIMICK, K. P. and CORSE, J.

Food Technol. **10** 360-364 (1956). *Chem. Abstr.* **50** 15979 (1956).

An apparatus using a katharometer detector is described in detail. Retention times are given for *n*-alcohols from C₃-C₈, and ethyl esters of *n*-acids from C₃-C₇ on silicone oil at 150°C, and also for ethanol, ethyl acetate, methyl ethyl ketone, benzene, *n*-heptane and water on silicone oil and Carbowax 1500. Methods of preparing suitable concentrates for gas chromatography from food are described.

395. Volatile Flavour of Strawberries. Minor Constituent Analysis by Gas Chromatography and Mass Spectrometry.

DIMICK, K. P. and CORSE, J.

Presented at 131st meeting of A.C.S. Miami, Florida, April 1957. Abstracts p. 2A No. 4.

Eight major fractions were isolated by gas chromatography on a column of silicone oil, from a small acid-free oil fraction boiling between 130 and 270°C. These fractions were further resolved on a Carbowax column,

and a large number of components separated. The relative retention time of each component was compared with known compounds using *iso*amyl alcohol as internal standard.

396. The Volatile Flavours of Strawberry.

DIMICK, K. P. and CORSE, J.

Am. Perfumer Aromat. **71** (2) 45, 48, 53 (1958). *Chem. Abstr.* **52** 6661 (1958).

An oil was obtained from strawberry purée by distillation and extraction with *iso*-pentane. By gas chromatography on silicone at 200°C, 8 peaks were obtained. Some of these were re-run on silicone or Carbowax columns at 100 or 150°C. A total of more than 30 peaks was obtained of which 8 were identified.

397. The Volatile Flavours of Strawberry.

DIMICK, K. P. and CORSE, J.

Quartermaster Food and Container Inst., Surveys Progr. Military Subsistence Problems. Ser. 1 No. 9. 123-132 (1957). *Chem. Abstr.* **52** 7564 (1958).

See previous reference.

398. Volatile Flavour of Strawberry Essence. I. Identification of the Carbonyls and Certain Low-Boiling Substances.

DIMICK, K. P. and MAKOWER, B. B.

Food Technol. **10** 73-75 (1956). *Chem. Abstr.* **50** 12341 (1956).

An oil fraction amounting to about 7% of the total essence appeared to contain all the substances contributing to the typical strawberry aroma. The amount of carbonyl present did not seem to be related to the intensity of the aroma. No experimental details are given in *Chem. Abstr.*

399. Volatile Flavour of Strawberries. II. Application of Gas-Liquid Partition Chromatography.

DIMICK, K. P., STITT, F. and CORSE, J.

Presented at 129th National A.C.S. Meeting, Dallas, Texas, April 1956. Abstracts p. 19B. No. 52.

A column using a silicone as stationary phase enabled 11 major fractions to be collected. Each of these was found to be a mixture which could be further resolved on a column using Carbowax as stationary phase. Several compounds have been definitely identified.

400. Chemical Techniques.

D'LENY, W.

Chem. and Ind. (London) 1957 (12) 338.

A description of gas chromatography in general terms as part of the article under the heading 'Analysis'.

401. Indiscriminate Reaction of Methylene with the C-H Bond.

DOERING, W. von E., BUTTERY, R. G., LAUGHLIN, R. G. and CHAUDHURI, N.

J. Am. Chem. Soc. **78** 3224 (1956). *Chem. Abstr.* **51** 199 (1957).

Gas-liquid partition chromatography was used to analyse the products of the reaction, and to isolate samples of pure products.

402. Vapour-Phase Chromatography in Air Pollution Studies: Column Evaluation.

DOLPHIN, J. L. and STANLEY, T. W.

Presented at 131st National A.C.S. Meeting, Miami, Florida, April 1957. Abstracts p. 36B No. 92.

A universal column packing has been developed for the determination of the more commonly occurring air pollutants, and a 2-stage unit has been constructed to enable analyses to be carried out in a reasonable time.

403. Analysis of the Anaesthetic Mixture of Schleich by Partition Chromatography Between Liquid and Gas Phases.

DOMANGE, L. and LONGUEVALLE, S.

Ann. pharm. franc. **15** (7-8) 448-454 (1957). *Chem. Abstr.* **52** 5745 (1958).

The mixture contains a 6 : 2 : 1 ratio of ether, chloroform and ethyl chloride respectively, and these components may be separated on a column of Silicone E.301 on Celite at 36°C, using nitrogen as carrier gas.

404. Electronics Controls Gas Chromatography.

DONNER, W.

Electronics **30** (11) 164-166 (1957). *Chem. Abstr.* **52** 1692 (1958).

A heat controller containing thermistors controls the temperature between 40 and 225°C. Other applications of the use of electronics in control of the gas chromatographic technique are discussed and a chromatogram of acetate esters is included.

405. Use of a Mass Spectrometer as a Gas Chromatograph Detector.

DONNER, W., JOHNS, T. and GALLAWAY, W. S.

Presented at 5th Ann. Meeting, ASTM Committee E-14 on Mass Spectrometry, New York, May 1957. Abstract in Anal. Chem. **29** (9) 1378 (1957).

An RF mass spectrometer was used in conjunction with a thermal conductivity cell. Using a rapid scan, a complete mass spectrum from m/e 12 to 100 was shown continuously on a cathode ray tube.

406. Metering Gas with a Heated Thermopile.

DOYLE, R. T.

Instr. and Automation **30** (12) 2276 (1957).

A gas flow indicator is described. Measurement of velocity, flow pressure and vacuum has been accomplished before, but the measurement of gas flow by this method has not previously been described.

407. Indication and Measurement of Gases and Vapours in Air or other Permanent Gases.

DRAGER, O. H.

B.P. 754,536 (1954).

The gaseous mixture is passed through a layer of granular absorbent material (active carbon or silica gel) arranged in an electromagnetic alternating field, the variations of which can be determined.

408. Theory of Gradient Elution Analysis.

DRAKE, B.

Arkiiv. Kemi. **8** 1-21 (1955). *Chem. Abstr.* **49** 13815 (1955).

In English. A mathematical derivation of some basic theoretical concepts, and a discussion on the efficiency of separation which can be expected from this type of technique.

409. The Application of Vapour-Phase Chromatography to the Study of Gas-Phase Reactions.

DREW, C. M. and McNESBY, J. R.

Presented at 129th National A.C.S. Meeting, Dallas, Texas, April 1956. Abstracts p. 20B No. 53.

The initial reaction products of the pyrolysis and photolysis of acetone-butane mixtures were analysed by gas chromatography using a column of pelleted carbon black partially deactivated with Octoil-S, at temperatures ranging from that of liquid nitrogen to room temperature.

410. Some Problems Encountered with the Application of Vapour-Phase Chromatography to Kinetic Studies.

DREW, C. M. and McNESBY, J. R.

I.P. Symposium, London, 1956. 213.

Ed. DESTY, D. H. Published by Butterworths 1957.

Vapour-phase chromatography in conjunction with mass spectrometry was adapted to the special problem of investigating gas-phase reactions. Provisions for the recovery of gas chromatography fractions required changes in the arrangement of the detector.

411. Recovery of Vapour-Phase Chromatography Fractions and their Analysis by Mass Spectrometry.

DREW, C. M., McNESBY, J. R., GORDON, A. S. and SMITH, S. R.

Presented at 4th Ann. Meeting, ASTM Committee E-14 on Mass Spectrometry, Cincinnati, Ohio, May 1956.

Some techniques for the recovery of vapour-phase chromatography samples are discussed and the mass spectrometric analyses of recovered fractions shown.

412. Application of Vapour-Phase Chromatography to Mass Spectrometer Analysis.

DREW, C. M., McNESBY, J. R., SMITH, S. R. and GORDON, A. S.

Anal. Chem. **28** (6) 979-983 (1956). *Chem. Abstr.* **50** 11157 (1956).

A technique is described for the analysis of gaseous mixtures by gas chromatography with simultaneous recovery of a portion of each separated fraction for mass spectrometric analysis. 5 isomers of hexane were separated on a paraffin oil/Celite column.

413. Gas Chromatography for Process Control.

DUDENBOSTEL, B. F. and PRIESTLEY, W.

Ind. Eng. Chem. **48** (9) 55A-56A (1956).

Esso Research and Engineering Company have released the details of a continuous plant analyser employing gas adsorption chromatography. Analyser is being used for continuous analysis of propane in propylene at Bayway Refinery polymerisation plant. A 20 ft activated alumina column is used.

414. Application of Process Control Analysis to Petroleum Refining.

DUDENBOSTEL, B. F. and PRIESTLEY, W.

Ind. Eng. Chem. **48** (11) 49A (1956).

Mentions the application of gas chromatography to process control analysis. No details of method or apparatus are given.

415. Developments in Process Control Analysis in 1956.

DUDENBOSTEL, B. F. and PRIESTLEY, W.

Ind. Eng. Chem. **49** (1) 99A (1957).

Contains a section on continuous plant analyses in which gas chromatography plays its part. Currently used for the determination of propane and propylene in polymerisation plants.

416. Gas Chromatography for Plant Stream Analysis.

DUDENBOSTEL, B. F. and SKARSTROM, C. W.

Advances in Gas Chromatography, A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D-177. Presented during 132nd Meeting, A.C.S.

An abstract only of a paper giving a general review of the subject.

417. A Liquid-Flow Regulator and its Application to a Constant-Rate Gas Sampler.

DUKE, J. R. C.

J. Soc. Chem. Ind. **58** (6) 231-232 (1939). *Chem. Abstr.* **33** 7153 (1939).

The regulator operates on the principle of the Edwards gas regulating bottle, the place of gas in the latter being taken by water or other liquid. Small errors due to displacement of mercury have been eliminated by the insertion of a sintered glass diaphragm which is permeable to water but not to mercury. The regulator has been used in the construction of a constant-rate gas sampler.

418. Chromatographic Examination of Industrial Gases by Means of a Semiautomatic Apparatus.

DUMAY, H.

J. usines gaz. **82** 107-114 (1958). *Chem. Abstr.* **52** 13230 (1958).

Uses adsorption and partition gas chromatography with carbon dioxide as eluent. The column was activated carbon, silica gel, or dioctyl phthalate on C22 firebrick.

419. Self-Balancing System for Continuous Control of Current or Voltage.

DUNN, F. J., MANN, J. B. and MOSLEY, J. R.

Anal. Chem. **27** (1) 167-168 (1955). *Chem. Abstr.* **49** 5170 (1955).

Describes, with diagrams, a method for the precise control of the heating current to the wire of a thermal conductivity cell.

420. The Qualitative and Quantitative Analysis of Heavy Tar Oils by Gas Chromatography.

DUPIRE, F. and BOTQUIN, G.

Anal. Chim. Acta **18** (4) 282-290 (1958). *Anal. Abstr.* **6** 248 (1959).

In French. The column used (2.5 m × 6 mm), was packed with C22 firebrick (60-80 mesh) impregnated with silicone grease (30%). Helium was used as carrier gas with thermal conductivity detection.

421. The Labelling of Fatty Acids by Exposure to Tritium Gas.

DUTTON, H. J., JONES, E. P., MASON, L. H. and NYSTROM, R. F.

Chem. and Ind. (London) 1958 (36) 1176.

Gas chromatography was used to analyse the irradiated samples, and thermal conductivity detection was compared with radioactivity detection.

422. Organic Peroxides. VI. Allyl Hydroperoxide.

DYKSTRA, S. and MOSHER, H. S.

J. Am. Chem. Soc. **79** 3474-3475 (1957). *Chem. Abstr.* **51** 16276 (1957).

Describes the use of gas chromatography to separate and purify reaction products.

- 423.** Operating Characteristics of the Leeds and Northrup Chromatograph Process Stream Analyser.

EANES, R. D.

Presented at Instr. Soc. Am. Symposium on Gas Chromatography, Michigan, August 1957.

No further details are available.

- 424.** Semi-Quantitative Gas Chromatography.

EASTMAN, R. H.

J. Am. Chem. Soc. **79** (15) 4243 (1957). *Chem. Abstr.* **51** 17330 (1957).

An expression is given which relates reasonably accurately the fraction by weight of a component in a mixture to its corresponding peak area, the latter being obtained using a tungsten wire thermal conductivity gauge and helium as carrier gas. The expression is only applicable to mixtures which can be completely resolved.

- 425.** Sensitivity of Vapour-Phase Chromatography Detectors.

EBEID, F. M. and MINKOFF, G. J.

Research Correspondence **9** (5) S24 (1956). *Chem. Abstr.* **52** 1690 (1958).

A brief review of detectors and an investigation of a thermal conductivity cell. A method of improving the sensitivity of thermal conductivity cells is given.

- 426.** The Analysis of Gas Mixtures by Means of the Desorption-Thermal-Conductivity Method.

EDSE, R. and HARTECK, P.

Angew. Chem. **52** 32-33 (1939). *Chem. Abstr.* **33** 3285 (1939).

A thermal conductivity cell replaces the gas gravity balance of previous workers, and a full description of the apparatus used is given. Experiments were carried out with silica gel and activated carbon.

- 427.** The Analysis of Gas Mixtures by Means of the Desorption-Thermal-Conductivity Method. II.

EDSE, R. and HARTECK, P.

Angew. Chem. **53** 210-213 (1940). *Chem. Abstr.* **34** 6897 (1940).

See previous reference. Experiments are reported for several hydrocarbon mixtures, H-D mixtures and some mixtures of other isotopes. Desorption diagrams are presented for 18 mixtures.

- 428.** Determination of 5- to 7-Carbon Saturates by Gas Chromatography.

EGGERTSEN, F. T. and GROENNINGS, S.

Presented at A.P.I. Division of Petroleum Meeting, Philadelphia, May 1957. Abstract in Petrol. Refiner **36** (5) 205 (1957).

See following reference.

- 429.** Determination of 5- to 7-Carbon Saturates by Gas Chromatography.

EGGERTSEN, F. T. and GROENNINGS, S.

Anal. Chem. **30** (1) 20-25 (1958). *Chem. Abstr.* **52** 8519 (1958).

3 separate columns were employed in this work as follows:—(1) 3% squalane on C22 firebrick, (2) 40% 2,2-oxydipropionitrile on firebrick, and (3) 1.5% squalane on Pelletex. Helium was used as carrier gas with thermal conductivity detection. In most cases the hydrocarbons were oxidised by copper oxide and detected as carbon dioxide.

430. Gas Chromatography. Effect of Type and Amount of Solvent on Analysis of Saturated Hydrocarbons.

EGGERTSEN, F. T. and KNIGHT, H. S.

Anal. Chem. **30** (1) 15-20 (1958). *Chem. Abstr.* **52** 8518 (1958).

In the gas chromatography of saturated hydrocarbons, adsorption on the surface of the support may be controlled to provide a wide selectivity range by adjusting the amount of solvent. The most retentive solvents were found to be ethylene glycol and 2,2-oxydipropionitrile. Thermal conductivity detection was used with helium as carrier gas.

431. Gas Chromatographic Analysis of Engine Exhaust and Atmosphere—Determination of C_2 to C_5 Hydrocarbons.

EGGERTSEN, F. T. and NELSON, F. M.

Anal. Chem. **30** (6) 1040-1043 (1958). *Chem. Abstr.* **52** 14416 (1958).

The threshold of detection is 0.05 ppm when using a column packed with firebrick + 40% dimethyl sulpholane, in conjunction with thermal conductivity detection and helium as carrier gas.

432. Use of Liquid-Modified Solid Adsorbent to Resolve C_5 and C_6 Saturates.

EGGERTSEN, F. T., KNIGHT, H. S. and GROENNINGS, S.

Anal. Chem. **28** (3) 303-306 (1956). *Chem. Abstr.* **50** 8391 (1956).

A new type of column packing for use in gas chromatography is described. It consists of an active solid to which a small amount of liquid solvent has been added. The amount of solvent is sufficient to prevent or greatly reduce the tailing of chromatographic peaks normally encountered with active solid supports, but not to replace the solid as the principal sorbing medium.

433. The Attempted Use of a Hydrogen Flame Detector with Corrosive Gases.
ELLIS, J. F. and FORREST, C. W.

U.K. Atomic Energy Authority, Ind. Group. IGR-TM/CA.042. 3 pp. (1956).

A hydrogen flame detector for gas chromatography has been shown to be insufficiently reliable for use with corrosive gases, e.g. F_2 , HF and ClF_3 .

434. The Application of Gas-Liquid Chromatography to the Analysis of Volatile Halogen and Interhalogen Compounds.

ELLIS, J. F. and IVESON, G.

Gas Chromatography 1958. Amsterdam Symposium—May 1958.

Ed. DESTY, D. H. Published by Butterworths 1958. 300-308. Discussion 308-309.

Mixtures of Cl_2 , ClF , ClF_3 , HF and UF_6 have been quantitatively analysed. Satisfactory elution curves can be obtained from Br_2 and BrF_5 , but they interact with Cl fluorides so cannot be analysed in their presence. Sample introduction systems suitable for high vacuum operation have been incorporated in the apparatus, thus enabling samples at sub-atmospheric pressures to be analysed.

435. Organo-Clay Complexes.

EMERSON, W. W.

Nature **180** (4575) 48-49 (1957). *Chem. Abstr.* **51** 17329 (1957).

A short discussion on organic complexes of montmorillonite and hallaysite.

436. Applications of Gas Chromatography.

EMMETT, P. H.

Gas Chromatography 1958. *Amsterdam Symposium—May 1958.*

Ed. DESTY, D. H. Published by Butterworths 1958. 267-269.

A short review and introduction to several papers presented on the applications of gas chromatography.

437. Method of Quantitative Separation of Helium-Neon Mixtures.

ERMOLIN, G. M.

Trudy Radievogo Inst. im. V. G. Khlopina 6 119-138 (1957). *Chem. Abstr.* 52 19404 (1958).Describes a method which is based on differences in the adsorptive ability of activated charcoal towards He and Ne at a temperature which closely approaches the critical temp. of Ne (-228.7°C). He and Ne in air can be determined by this method.**438. Chromatography of Gases. I.**

ESAYAN, I. L. and ESAYAN, M.

Rev. Chim. (Bucharest) 8 447-452 (1957). *Chem. Abstr.* 52 4397 (1958).In Roumanian with English Summary. A review which also contains a description of the separation of C_2H_2 , H_2 and CH_4 by adsorption on charcoal.**439. Gaseous Chromatography. II.**

ESAYAN, I. L., GHERMAN, M., STEFAN, V. and ISTRATE, E.

Rev. Chim. (Bucharest) 9 125-128 (1958). *Chem. Abstr.* 53 5962 (1959).

In Roumanian with an English summary. Describes the analysis of a mixture of acetylene, vinyl chloride and air using a column packed with dibutyl phthalate on kieselguhr.

440. Automatic Procedure for the Microanalytical Separation of Low Boiling Hydrocarbons by Desorption.

EUCKEN, A. and KNICK, H.

Brennstoff-Chem. 17 241-244 (1936). *Chem. Abstr.* 31 1727 (1937).

An apparatus is described for the separation of known mixtures of methane, ethane, ethylene and propane on activated carbon.

441. Preparative-Scale Gas Chromatography.

EVANS, D. E. M., MASSINGHAM, W. E., STACEY, M. and TATLOW, J. C.

Nature 182 (4635) 591-592 (1958). *Chem. Abstr.* 53 4827 (1959).Describes the separation of organic fluorine compounds on very large columns—16 ft $\times$ 75 mm I.D. packed with dinonyl phthalate/kieselguhr (1:2). The carrier gas was nitrogen and the column temperature $71-110^{\circ}\text{C}$. 50 g charges may be separated with an efficiency of 80-100%. The paper also describes a modified katharometer unit.**442. The Reactions of Highly Fluorinated Organic Compounds. VIII. Gas Chromatographic Separation on a Preparative Scale, and some Reactions of 3H- and 4H-Nonafluorocyclohexene.**

EVANS, D. E. M. and TATLOW, J. C.

J. Chem. Soc. 1955 1184-1188. *Chem. Abstr.* 50 1617 (1956).

Gas-liquid partition chromatography has been applied to the separation of mixtures of volatile compounds with closely related boiling points in cases where fractional distillation is difficult.

- 443.** The Application of Gas Chromatography to Organic Fluorine Chemistry.
EVANS, D. E. M. and TATLOW, J. C.
I.P. Symposium, London, 1956. 256.
Ed. DESTY, D. H. Published by Butterworths 1957.
Analytical scale columns are used for following reactions, identification of products and assaying purity. No single packing seems to be satisfactory for general application. Preparative scale columns have been developed for separation of 1-10 g of volatile mixtures and are now in general use.
- 444.** Use of Gas-Phase Chromatography for the Separation of Mixtures of Carrier Free Radioactive Substances: Products of Chemical Reactions Activated by Nuclear Processes.
EVANS, J. B. and WILLARD, J. E.
J. Am. Chem. Soc. **78** (12) 2908-2909 (1956). *Chem. Abstr.* **50** 11847 (1956).
Over 20 different radioactive organic compounds from a drop of neutron irradiated *n*-propyl bromide have been separated by gas chromatography, and their presence detected with the aid of a scintillation counter. The techniques evolved should be valuable in the separation of radioactive products formed by the photolysis or radiolysis of radioactive compounds.
- 445.** Evidence from Gas Chromatography on the Multiplicity of Radioactive Products formed in Organic Media by the Activation of Halogens by Nuclear Processes.
EVANS, J. B., QUINLAN, J. E. and WILLARD, J. E.
Presented at A.C.S. Meeting of the Division of Physics and Inorg. Chem., Atlantic City, September 1956.
No further details are available.
- 446.** Making Labelled Compounds—Chemical Effects of Nuclear Transformations.
EVANS, J. B., QUINLAN, J. E. and WILLARD, J. E.
Ind. Eng. Chem. **50** (2) 192-195 (1958). *Chem. Abstr.* **52** 6953 (1958).
Using a 12 ft $\times$ 4 mm glass column packed with C22 firebrick impregnated with 40% G.E. SF-96 silicone oil, unweighable amounts of labelled compounds could be separated. The temperature of the column could be varied between 40 and 200°C, and helium was used as carrier gas with thermal conductivity detection.
- 447.** Gas Chromatography—Versatile Analytical Tool for Quality Control and Research.
FAGERSON, I. S.
Food Eng. **29** (2) 62-63 (1957).
This article briefly describes the use of gas chromatography in food research in connection with the following problems:—the relation of off-flavours and pesticide treatment of fruit and vegetables, flavour and enzyme activity in vegetables, odorous compounds of strawberries, and off-flavours in irradiated meat.
- 448.** Toxicologic Studies on Organic Sulphur Compounds. I. Acute Toxicity of some Aliphatic and Aromatic Thiols (Mercaptans).
FAIRCHILD, E. J. and STOKINGER, H. E.
Presented at Am. Ind. Hygiene Assoc. Meeting, St. Louis, April 1957.
Printed in Am. Ind. Hygiene J. **19** (3) 171-189 (1958).
The purity of 6 of the mercaptans used in this study was checked by means of vapour-phase chromatography. No details are given.

449. A High Temperature Gas Chromatography Apparatus.

FAWCETT, J. S. and TAYLOR, B. W.

Advances in Gas Chromatography, A.C.S. Symposium, New York, September 1957. Published by A.C.S. 1957. D-85 to D-89. Presented during 132nd Meeting, A.C.S.

Gives a full description of a new instrument incorporating a newly designed thermistor type thermal conductivity cell, with thermistor regulated cell temperatures up to 200°C, a regulated column temperature up to 300°C, and a flash evaporator up to 425°C. Stationary phases which have proved fairly suitable for operation at these temperatures are:—Apiezon grease L, Silicone High Vacuum grease, Stearone and polyethylene.

450. Adsorption and Desorption of Nitrogen on Charcoal.

FEJES, P. and SCHAY, G.

Acta Chim. Acad. Sci. Hung. 14 439-452 (1958). Chem. Abstr. 52 15187 (1958).

In English. Adsorption isotherms at 20, 40 and 60°C were determined by frontal gas chromatography using hydrogen as carrier gas. These isotherms were found to be linear up to atmospheric pressure.

451. Chromatography Analyses Gas and Vapour Products in the Plant.

FELLOWS, E. G.

Control Eng. 4 (7) 75-81 (1957).

This article contains a description of chromatographic equipment, including columns for both gas-adsorption and gas-partition, detectors and carrier gases. The basic concepts of a process stream analyser are enumerated, with a full description of a sampling system and its mode of operation.

452. Novel Use High Temperature Gas Chromatography Unit.

FELTON, H. R.

Chem. Age 78 (1955) 563 (1957).

The column contains Silicone grease and a novel detector which employs model airplane 'glow plugs' as sensing elements, permitting operations at temperatures exceeding 550°C. Mixtures boiling at over 400°C can be analysed. See also following abstract.

453. A Novel High Temperature Gas Chromatography Unit.

FELTON, H. R.

*Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.**Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 131.*

Gives a full description of a unit which may be used at temperatures over 500°C. The most satisfactory column packing for use at such temperatures was found to be Dow Corning high vacuum grease (20%) on Celite, but this required 'conditioning' at 400°C for 2-3 hours in a helium flow of 25 ml/min. The thermal conductivity cell uses model airplane 'glow plugs' as sensing elements. Examples of the applications of this apparatus are:—the analysis of the fluoroalcohol esters of camphoric acid, isomers of N-phenylnaphthylamine and toluene isocyanates.

454. High Temperature Thermal Conductivity Cell.

FELTON, H. R. and BUEHLER, A. A.

Anal. Chem. 30 (6) 1163 (1958). Chem. Abstr. 52 14240 (1958).

Useful for high temperature gas chromatography. Uses model airplane 'glow plugs' rather than thermistors or filaments. Gives a full description of the cell.

- 455.** The Separation of Olefin and Paraffin Hydrocarbon Gases by Means of the Olefin-Copper Chloride Complex.
FERBER, E. and ANDERS, L.
Die Chemie **57** 119-123 (1944). *Chem. Abstr.* **40** 4621 (1946).
A combination of this method with low temperature fractionation gives an accurate method for the analysis of gaseous hydrocarbons. Very pure olefins may be prepared from the complex with copper chloride, and the method could be easily adapted to a technical scale.
- 456.** The Quantitative Analysis of Gaseous Paraffin Hydrocarbons by Adsorption and Desorption.
FERBER, E. and LUTHER, H.
Angew. Chem. **53** 31-35 (1940). *Chem. Abstr.* **34** 3203 (1940).
Fractional distillation is included as a preliminary to adsorption analysis. The gas is condensed at -183°C and the condensate allowed to evaporate slowly. Butane and some propane are absorbed by activated alumina at -120°C , the rest of the propane and the ethane condensed at -183°C and then the methane adsorbed on charcoal at -170°C . The remainder is hydrogen which is measured directly. Binary mixtures were analysed by combustion methods.
- 457.** Gas Chromatography: A New Technique.
FERRER, P.
Afinidad **33** (165/166) 199-208 (1956).
In Spanish. A general description of the principles of gas chromatography with sections on both adsorption and partition. The advantages of the method are discussed and some applications are outlined.
- 458.** Foreign Automatic Chromatographic Gas Analysers.
FESENKO, E. P.
Zavodskaya Lab. **34** (1) 123 (1958).
A review of British, U.S.A. and Italian gas chromatography apparatus.
- 459.** Gas Analyser.
FIEHMAN, J.
Chem. prumysl. **7** 605-606 (1957). *Chem. Abstr.* **52** 13325 (1958).
The principle of indirect measurement of the thermal conductivity of a mixture of 2 gases was employed in a device which was developed for the analysis of gases in the atmosphere. The thermal conductivities of the 2 gases must however differ sufficiently to make the measurements possible.
- 460.** Automatic Gas Chromatograph.
FISCHER, J.
Presented at Symposium on Gas Chromatography, Leipzig, October 1958. Preprints 22-38.
In German. Gives details of the construction of the equipment and the functioning of an electronic timing device. A diagram of the control circuit is included.
- 461.** Irradiation Studies of Small Concentrations of Automobile Exhaust in Air using Gas Chromatography.
FORD, H. W.
Presented at 133rd Natl. Meeting Am. Chem. Soc., San Francisco, April 1958. Abstracts p. 4Q No. 8.
After dilution with pure air, the sample was irradiated, passed through an Ascarite filter and trapped at liquid oxygen temperature. Aliquots were analysed using a column of dimethyl sulpholane on C22 firebrick.

462. Facts on Flavour.

FORSS, D. A.

Australian J. Dairy Technol. **12** 120-126 (1957). *Chem. Abstr.* **52** 3187 (1958).

A discussion on flavours in dairy products caused by the presence in food of various weeds or induced during sterilisation with gamma rays. Volatile flavours have been separated by means of gas chromatography and the fractions identified by spectrophotometry.

463. Analysis of 2-Bromopentane.

FORTUNE, W. B.

Anal. Chem. **29** (1) 28A (1957). *Chem. Abstr.* **51** 3088 (1957).

No details are given in *Chem. Abstr.* Analysis by gas-partition chromatography has shown the presence of other isomers and pentenes. Knowing these impurities, it has been possible to change reaction processes to give increased yields of products.

464. What's New in Chromatography? Monitoring and Control with Automatic Chromatographic Analysers.

FOURROUX, M. M.

Oil Gas J. **56** (16) 114-116 (1958). *Chem. Abstr.* **52** 15883 (1958).

Describes the use of a 5 ft silicone column to control a natural gas liquids debutaniser tower, by measuring the isopentane content, and controlling this within narrow limits.

465. Gas Chromatographic Analysis of Alcohol and Certain Other Volatiles in Biological Material for Forensic Purposes.

FOX, J. E.

Proc. Soc. Exptl. Biol. Med. **97** 236-237 (1958). *Chem. Abstr.* **52** 9866 (1958).

The distillate from the fractional distillation of small samples of blood is analysed on glycol columns for ethanol, methanol, acetaldehyde, etc. Full experimental details of the columns used are given.

466. Better Refinery Operation with Automatic Stream Analysers.

FRAADE, D. J.

Oil Gas J. **55** (42) 93-103 (1957). *Chem. Abstr.* **52** 5797 (1958).

Gives a review of the use of various process stream analysers, including mass spectrometry, infra-red analysis, and vapour-phase chromatography.

467. Continuous Stream Analysis—Your Key to Process Profits.

FRAADE, D. J.

Proc. Control and Automation **4** (7) 269-271 (1957).

A general discussion of gas chromatography and description of an explosion proof housing for a process analyser used in hazardous atmospheres.

468. Apparatus for Automatic Evaluation of Chromatograms and Electropherograms.

FRANEK, F. and MASTNER, J.

Chem. Listy. **51** 1773-1775 (1957). *Chem. Abstr.* **52** 4 (1958).

An electronic densitometer is described. It registers the integral of the extinction coefficient of stains on chromatograms and allows evaluation without measuring areas.

- 469.** Analysis of Gaseous Hydrocarbons by Gas-Liquid Partition Chromatography.
FREDERICKS, E. M. and BROOKS, F. R.
Anal. Chem. **28** (3) 297-303 (1956). *Chem. Abstr.* **50** 8391 (1956).
Results indicate that good resolution of most of the hydrocarbons through C_5 can be achieved with a 2-stage column in which the sample is partitioned first by di-isodecyl phthalate and then by dimethylsulpholane. Use of a 50 ft column containing only dimethylsulpholane separates isobutylene from 1-butene and gave excellent resolution of the pentenes. Helium is used as the carrier gas.
- 470.** Separation of Hydrocarbons by Urea Adduction.
FREUND, M. and BATHORY, J.
Erdol u Kohle **9** 237 (1956). *Chem. Abstr.* **50** 17398 (1956).
Several examples are given in which urea is used for the fractionation of hydrocarbon mixtures.
- 471.** Chemical Engineering Design of a Unit for Continuous Gas Chromatography (Hypersorption).
FREUND, M., BENEDEK, P. and SZEPESY, L.
I.P. Symposium, London, 1956. 359-376.
Ed. DESTY, D. H. Published by Butterworths 1957.
In connection with the separation of the end gas of the partial oxidation of CH_4 , the one-pass recovery of C_2H_2 on activated carbon by continuous gas chromatography was investigated. A pilot unit and the technique are described. Principles for the chemical engineering design are given on the basis of which a unit on a commercial scale was designed.
- 472.** Formation of Cyclopropane from Methylene and Ethylene.
FREY, H. M.
J. Am. Chem. Soc. **79** 1259-1260 (1957). *Chem. Abstr.* **51** 11259 (1957).
The products of reaction were separated by the use of gas chromatography.
- 473.** Reactions of Methylene. I. Ethylene, Propane, Cyclopropane and *n*-Butane.
FREY, H. M. and KISTIAKOWSKY, G. B.
J. Am. Chem. Soc. **79** (24) 6373 (1957). *Chem. Abstr.* **52** 6204 (1958).
Gas chromatography was used to separate the products of reaction on a 6 ft column with thermal conductivity detection.
- 474.** Partition of Methylchlorosilanes by Gas-Liquid Chromatography.
FRIEDRICH, K.
Chem. and Ind. (London) 1957 (2) 47. *Chem. Abstr.* **51** 6436 (1957).
The following have been separated and identified: $-HSiCl_3$, $SiCl_4$, $MeSiHCl_2$, Me_3SiCl , $MeSiCl_3$, Me_2SiCl_2 . The column (1,300 mm $\times$ 4 mm) was maintained at 25°C, and contained Infusorial earth dehydrated at 300°C in vacuo as support for nitrobenzene (30% by wt). Nitrogen was used as carrier gas, and the exit gases were passed through 0.02N KCl where they were hydrolysed. Changes in acidity were measured by recording conductivity.
- 475.** Analysis and Identification of Asphaltic Petroleum Products.
FUCHS, W. and NETTESHEIM, G.
Erdol u Kohle **10** 15-20 (1957). *Chem. Abstr.* **51** 18561 (1957).
Describes the separation into fractions by adsorption chromatography on silica gel.

476. Gas-Liquid Chromatography.

FUKS, N. A.

Uspekhi. Khim. **25** 845-858 (1956). *Chem. Abstr.* **50** 15324 (1956).

Essentially a review of the principles of gas chromatography.

477. Vapour-Phase Chromatography. II. Quantitative Analysis with a Chromatographic Apparatus.

FUKUDA, TOMIO., OMORI, H. and KUSAMA, T.

Bunseki Kagaku **6** (10) 647-650 (1957). *Chem. Abstr.* **52** 15321 (1958).A column of activated carbon separated H_2 , O_2 , CO , CO_2 and hydrocarbons lower than C_3 , but diatomaceous earth + tributyl phosphate was used for hydrocarbons higher than C_3 . Detection was by thermal conductivity.**478. Vapour-Phase Chromatography.**

FUKUDA, TOSAO.

Yuki Gosei Kagaku Kyokai Shi **15** 577-583 (1957). *Chem. Abstr.* **52** 1725 (1958).

A review giving 25 references.

479. Vapour-Phase Chromatography. I. The Adsorbents Required for Adsorption Displacement Chromatography.

FUKUDA, TOSAO.

Bunseki Kagaku **6** 359-362 (1957). *Chem. Abstr.* **52** 15321 (1958).

Various kinds of activated carbon were tested. A description of the apparatus used and some results are given.

480. Construction of the Apparatus for Gas Chromatography.

FUKUDA, TOSAO.

Kagaku no Ryoiki **12** 585-589 (1958). *Chem. Abstr.* **52** 19338 (1958).A symposium lecture article. No details are given in *Chem. Abstr.***481. Gas Chromatography in Plant Streams.**

FULLER, D. H.

ISAJ. **3** (11) 440-444 (1956).

A general descriptive article which gives the requirements of a plant stream analyser and also block diagrams of such an analyser and its associated computer and display equipment. A diagram is also given of a complete sampling system, and the selection of operating conditions is discussed. Some applications of such an apparatus are considered.

482. Vapour-Phase Chromatography in Tobacco Research.

GAGER, F. L.

Presented at Southwide Chem. Conf. on Instrumentation, Instr. Soc. Am. Symposium on Gas Chromatography, Memphis, Tennessee, December 1956. No further details are available.**483. Investigation of the Combined Use of Mass Spectroscopy and Gas Chromatography.**

GALLAWAY, W. S. and JOHNS, T.

Presented at 8th Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, March 1957. Abstract in Appl. Spectroscopy **11** (2) 102 (1957).

Describes an investigation of the use of a mass spectrometer as a detector in gas chromatography.

- 484.** Micro Infra-Red Gas Chromatographic Techniques as Applied to Complex Organic Systems.

GALLAWAY, W. S., JOHNS, T., TIPOTSCH, D. G. and ULRICH, W. F.
Presented at Pittsburgh Conf. on Anal. Chem., March 1958. Paper 111.

No further details are available.

- 485.** Effect of Packing Configuration on Mass and Heat Transfer in Beds of Packed Spheres.

GALLOWAY, L. R., KOMARNICKY, W. and EPSTEIN, N.

Can. J. Chem. Eng. **35** 139-150 (1957). *Chem. Abstr.* **52** 3425 (1958).

Experiments are described for the simultaneous measurement of the rates of mass and heat transfer for the evaporation of water into air from the surface of assemblies of uniform Celite spheres in the Reynolds number range 300-1,200. 2 orthorhombic, 1 rhombohedral and 2 cubic assemblies were tested.

- 486.** The Hydrothermal Chemistry of Silicates. VI. A Lamellar Habit in Synthetic Felspar.

GARD, J. A., BARRER, R. M. and BAYNHAM, J. W.

J. Chem. Soc. 1955 2480-2481. *Chem. Abstr.* **49** 13728 (1955).

Very thin lamellar crystals of synthetic potash felspar have been found associated in some preparations with major yields of synthetic leucite and in others with major yields of synthetic felspar of normal prismatic habit.

- 487.** Separation of Low-Boiling Hydrocarbons by Adsorption in the Vapour-Phase.

GARNER, F. H., ELLIS, S. R. M., STEER, D. C. and THOMPSON, D. W.

Genie chim. Suppl. **78** (5) 124-151 (1957). *Chem. Abstr.* **52** 9975 (1958).

Activated coconut charcoal was used as adsorbent, and was suspended in the superheated vapours of binary mixtures of hydrocarbons. The latter included benzene and methylcyclohexane, which were separated from ethanol and methyl ethyl ketone. The design of a continuous separation process was discussed.

- 488.** The Methylation of Cyclopentanones.

GAULT, F. G., GERMAIN, J. E. and CONIA, J. M.

Bull. soc. chim. France 1957 1064-1069. *Chem. Abstr.* **52** 4509 (1958).

The products of various reactions were separated by gas chromatography.

- 489.** Gas Chromatography of Hydrocarbons.

GAYLOR, V. F. and JONES, C. N.

Presented at 2nd Ann. Conf., Cleveland Soc. of Spectroscopy, May 1957. Abstract in Appl. Spectroscopy **11** (3) 141 (1957).

Gas chromatography was used to analyse gaseous mixtures of C₂-C₄ paraffins and olefins, paraffin isomers, and the light naphtha fraction of petroleum. No experimental details are given in the abstract.

- 490.** Analysis of the Hydrocarbons and Impurities in Liquid Gas.

GETOFF, N. and SATTLER-DORNBACHER, E.

Prakt. Chem. **7** (6) 159-162 (1956). *Anal. Abstr.* **4** 960 (1957).

The various methods available for the analysis of hydrocarbons are described and the use of gas chromatography for this purpose is discussed.

491. Cracking of Methane in a Tubular Reactor. I. Effect of the Ratio of Surface to Volume.

GERMAIN, J. E. and VANISCOTTE, C.

Bull. soc. chim. France 1957 692-696. *Chem. Abstr.* **51** 12464 (1957).

The cracking of methane was studied at 1,000°C in a silica reactor, and the product gases were determined by vapour-phase chromatography.

492. Device for Regulating Small Flow Rates in Chromatographic Columns.

GEVANTMAN, L. H., MAIN, R. K. and BRYANT, L. M.

Anal. Chem. **29** (1) 170 (1957). *Chem. Abstr.* **51** 4767 (1957).

The device consists of an auxiliary column containing powdered glass, which is fitted below the chromatographic column by means of a ground glass joint.

493. Purification of the Rare Gases. I. A Comparison of Active Metals in the Purification of Rare Gases.

GIBBS, D. S., SVEC, H. J. and HARRINGTON, R. E.

Ind. Eng. Chem. **48** (2) 289-296 (1956). *Chem. Abstr.* **50** 8978 (1956).

Fifteen metals and alloys have been investigated to determine their relative efficiencies in removing impurities from a stream of argon or nitrogen. In the case of all the metals studied, the results demonstrated the necessity of carefully controlling the temperature and the gas flow rate through the purification chamber.

494. Stochastic Considerations on Chromatographic Dispersion.

GIDDINGS, J. C.

J. Chem. Phys. **26** (1) 169-173 (1957). *Chem. Abstr.* **51** 7100 (1957).

The band structure problem is approached using concepts from discrete probability theory and passing to the limit for the continuous case. The paper is a theoretical analysis of the chromatographic process.

495. Kinetic Relaxation-Time Model Applied to Nonequilibrium-Diffusion Effects in Chromatography.

GIDDINGS, J. C.

Presented at 133rd Meeting A.C.S., San Francisco, April 1958. Abstract p. 8Q No. 21.

Connecting links between the various theories of chromatography are discussed. The stochastic theory, the theoretical-plate theory, and the material-conservation approach are separately treated, and also in relation to each other, the latter 2 being considered as problems in nonequilibrium kinetics. The source of nonequilibrium is discussed, its quantitative treatment depending on the use of the kinetic relaxation-time model.

496. A Molecular Dynamic Theory of Chromatography.

GIDDINGS, J. C. and EYRING, H.

J. Phys. Chem. **59** (5) 416-421 (1955). *Chem. Abstr.* **49** 11358 (1955).

The molecular dynamic problem of passage of substances through a chromatographic column is investigated for the linear range of the adsorption isotherm. It is found, assuming uniform adsorption sites of only 1 type, that a reasonable concentration distribution of molecules in the effluent of a column can be obtained. Equations are also derived for the case in which there are 2 or more different type sites. The sorption rate constants of a typical chromatographic process are experimentally determined.

497. Vapour-Phase Chromatography.

GIFFORD, A. P.

Instr. and Automation **30** (12) 2264 (1957).

A general descriptive article giving the advantages, limitations, and applications of gas chromatography to process monitoring.

498. Gas-Liquid Partition Chromatography of Mixtures of the Three Isomeric Methylcyclohexenes and Methylene cyclohexane.

GIL-AY, E., HERLING, J. and SHABTAI, J.

Chem. and Ind. (London) 1957 (45) 1483-1484. *Chem. Abstr.* **52** 4413 (1958).

A Perkin-Elmer Model 154 Fractometer was used in this investigation. The column (2 m) was packed with 1 part of saturated silver nitrate/glycol solution supported on 2 parts of Sterchamol (50-80 mesh), the temperature was 30°C and helium was used as carrier gas.

499. Gas-Liquid Partition Chromatography of Mixtures of Methylene cyclohexane and the Isomeric Methylcyclohexenes.

GIL-AY, E., HERLING, J. and SHABTAI, J.

J. Chromatog. **1** (6) 508-512 (1958).

See previous reference. This paper describes the subject matter more fully.

500. Diffusion Coefficients in Gaseous Systems.

GILLILAND, E. R.

Ind. Eng. Chem. **26** (6) 681-685 (1934). *Chem. Abstr.* **28** 4643 (1934).

A literature review on diffusion coefficients of gaseous systems at various temperatures, containing data on organic vapours diffusing in air.

501. Rates of Flow Through Microporous Solids.

GILLILAND, E. R., BADDOUR, R. F. and RUSSELL, J. L.

A.I.Ch.E. Journal **4** (1) 90-96 (1958). *Chem. Abstr.* **52** 8637 (1958).

The rates of flow of pure gases were investigated, using both those showing no adsorption, and those showing an appreciable adsorption, through plugs of activated carbon and unsintered Vycor glass. By using the existing gas-phase flow theories, the permeabilities of the solids to hydrogen, helium, argon and nitrogen were obtained.

502. Chromatographic Separation of Phosphonitrilic Chlorides by Vapour-Phase Techniques.

GIMBLETT, F. G. R.

Chem. and Ind. (London) 1958 (12) 365-366. *Chem. Abstr.* **52** 12511 (1958).

A Griffin and George apparatus having a platinum katharometer was used in this investigation. The column used was 30% E.301 Silicone supported on Celite 545 at 205°C, and nitrogen was used as carrier gas.

503. Gas Chromatography: A Review.

GJALDBAEK, J. C.

Dansk. Tidsskr. Farm. **31** 225-240 (1957).

In Danish. A review dealing with the principles and the technique of gas chromatography.

504. Use of Iron Oxides for Chromatographic Adsorption.

GLEMSE, O. and RIECK, G.

Angew. Chem. **69** 91-93 (1957). *Chem. Abstr.* **51** 13833 (1957).

The selectivity and activity of Fe_2O_3 is greater than that of Al_2O_3 , and it has many uses. The method of preparation is given, and precautions are stated for ensuring the material is of the highest activity.

505. Stopcock for Gas Chromatography.

GLEW, D. N. and YOUNG, D. M.

Anal. Chem. **30** (11) 1890 (1958). *Chem. Abstr.* **53** 1861 (1959).

The stopcock is fully described and illustrated.

506. New Trends in Analysis of Gaseous Hydrocarbons.

GLOGOCZOWSKI, J. J.

Nafta (Poland) **12** 268-273 (1956). *Chem. Abstr.* **51** 16206 (1957).

The analysis of gaseous hydrocarbons by adsorption chromatography, and chromatothermography is discussed, and a modified Janak type apparatus is described.

507. Contributions to the Theory of Chromatography.

GLUECKAUF, E.

Proc. Roy. Soc. (London) A **186** 35-57 (1946). *Chem. Abstr.* **40** 6932 (1946).

The process of chromatographic separation is analysed for the case of 2 solvents, the adsorption of which follows a Langmuir isotherm. The development of bands is discussed, and it was found that simple conditions apply to both the volume of solvent and amount of adsorbent required for complete separation.

508. Quantitative Separation of Fission Product Krypton and Xenon.

GLUECKAUF, E.

Part of discussion of a paper presented at Int. Congr. on Anal. Chem., Oxford, 1952. Reported in Analyst **77** 903 (1952).The gases were adsorbed on active charcoal and eluted with hydrogen at -45°C for krypton and $+50^{\circ}\text{C}$ for xenon. Detection was by radioactivity, and the purity of the components was checked by mass spectrometry.**509. Theory of Chromatography. IX. The 'Theoretical Plate' Concept in Column Separations.**

GLUECKAUF, E.

Trans. Faraday Soc. **51** (1) 34-44 (1955). *Chem. Abstr.* **49** 11326 (1955).

A re-examination of the 'theoretical plate' treatment for chromatographic separations. The 'discontinuous flow treatment' of Mayer and Tompkins is replaced by a 'continuous flow' model. The paper also contains a discussion on the prediction of column performance with reference to the effect of feed band width, purity of separated products and the effects of non-equilibrium in the particles.

510. Theory of Chromatography. X. Formulae for Diffusion into Spheres and their Application to Chromatography.

GLUECKAUF, E.

Trans. Faraday Soc. **51** (11) 1540-1551 (1955). *Chem. Abstr.* **50** 11079 (1956).

A method of testing various empirical diffusion equations which show the rate of the mean internal concentration change as a function of both the mean internal concentration and the surface concentration, is described and discussed.

511. Principles of Operation of Ion-exchange Columns.

GLUECKAUF, E.

In 'Ion Exchange and its Applications' 34-36. *Soc. Chem. Ind. London* 1955.

This paper gives a qualitative survey of the various features affecting the

working and efficiency of ion-exchange columns. The second part is a quantitative (mathematical) discussion of the column process and gives simple equations for the calculation of the HETP. The third part applies these results to some practical problems.

512. Theory of Chromatography. XI. Enrichment of Isotopes by Chromatography.

GLUECKAUF, E.

Trans. Faraday Soc. **54** (8) 1203-1205 (1958).

It is demonstrated that isotope separation data obtained by elution chromatography can be represented by a linear plot of the log of the local separation coefficient as ordinate against the fraction of the eluted mixture on a probability scale abscissa.

513. Theory of Chromatography. XII. Chromatography of Highly Radioactive Gases.

GLUECKAUF, E.

Gas Chromatography 1958. Amsterdam Symposium—May 1958.

Ed. DESTY, D. H. Published by Butterworths 1958. 69-85. Discussion 85-89.

As a result of the temperature rise occurring in the adsorbent of the column during the passage of a highly radioactive band, the rear end of the band tends to move faster than its front. This results in a marked contraction of the bands, which finally reach a width which is independent of the original width of the feed band and of the length of the column. Both these effects are opposite to the behaviour of inactive gases in a column, and they are quantitatively discussed.

514. Krypton and Xenon Contents of Atmospheric Air.

GLUECKAUF, E. and KITT, G. P.

Proc. Roy. Soc. (London) A **234** 557-565 (1956). *Chem. Abstr.* **50** 9072 (1956).

The method used for the determination is a combination of distillation and low temperature gas chromatography. The use of radioactive Kr⁸⁵ as tracer gas provides a means of controlling the separation on the chromatographic column.

515. Gas Chromatographic Separation of Hydrogen Isotopes.

GLUECKAUF, E. and KITT, G. P.

I.P. Symposium, London, 1956. 422-427.

Ed. DESTY, D. H. Published by Butterworths 1957.

The complete purification of D₂ from D₂/H₂ mixtures has been achieved by passage of a 1:1 mixture through a column containing Pd black on asbestos at room temperature.

516. Separation of Hydrogen Isotopes by Gas Chromatography.

GLUECKAUF, E. and KITT, G. P.

Proc. Intern. Symposium Isotope Separation, Amsterdam, 1957 (Published 1958).

Ed. KISTAMAKER, J., BIGELEISEN, J. and NIER, A. O. C. 227-242. Chem. Abstr. **52** 11597 (1958).

No details given in *Chem. Abstr.* The adsorption on Pd/asbestos in the following order, tritium, deuterium, hydrogen, is discussed.

- 517.** Theory of Chromatography. VIII. The Separation of Lithium Isotopes by Ion-exchange and of Neon Isotopes by Low-Temperature Adsorption Columns.

GLUECKAUF, E., BARKER, K. H. and KITT, G. P.

Discussions Faraday Soc. 1949. No. 7 199-213. *Chem. Abstr.* **44** 9771 (1950).

Preliminary experiments to separate lithium isotopes by ion-exchange columns have been carried out. In the case of lithium almost pure Li^7 was obtained, but the quantity of material enriched was far less than expected. In neon separations, the effect of variations in experimental conditions on the enrichment is well represented by theoretical equations.

- 518.** Application of Gas Chromatography to the Analysis of the Rare Gases and some Permanent Gases.

GNAUK, G. and FRENZEL, J.

Presented at Symposium on Gas Chromatography, Leipzig, October 1958. Preprints 39-58.

In German. Type 5A molecular sieves are recommended for the separation at room temperature of mixtures of A/N_2 , O_2/N_2 , Kr/CH_4 . Using a thermal conductivity cell, 5×10^{-2} vol% Kr in O_2 can be directly determined. With N_2 or A as carrier gas it is possible to determine 10^{-8} mol He and 5×10^{-9} mol H_2 .

- 519.** Hexafluorobenzene.

GODSELL, J. A., STACEY, M. and TATLOW, J. C.

Nature **178** 199-200 (1956). *Chem. Abstr.* **51** 3472 (1957).

Gas chromatography was used to control fractional distillation and to separate 5 g of pure hexafluorobenzene.

- 520.** The Use of Time-of-Flight Mass Spectrometry and Vapour-Phase Chromatography in the Identification of Unknown Mixtures.

GOHLKE, R. S.

Advances in Gas Chromatography—A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D-77 to D-83. (Presented during 132nd Meeting, A.C.S.)

Describes the use of a combination of gas chromatography for the separation of mixtures of volatile substances and of mass spectrometry for the identification of the separated components.

- 521.** Instrument Design for Gas-Liquid Partition Chromatography.

GOHLKE, R. S.

Anal. Chem. **29** (11) 1723-1727 (1957). *Chem. Abstr.* **52** 4250 (1958).

A gas chromatography unit is described which can be constructed for less than 300 dollars.

- 522.** Time-of-Flight Mass Spectrometry and Gas Chromatography.

GOHLKE, R. S.

Presented at Pittsburgh Conf. on Anal. Chem., March 1958. Paper 142. No further details are available, but see reference 520.

- 523.** The Use of Vapour-Phase Chromatography in the Identification of Unknown Mixtures.

GOHLKE, R. S. and McLAFFERTY, F. W.

Presented at 129th National A.C.S. Meeting, Dallas, Texas, April 1956. Abstracts p. 18B No. 49.

The use of gas chromatography in the preparation of pure materials and for the determination of impurities is described. Identification of com-

ponents by mass spectrometry or i.r. can be facilitated if the purity has already been determined by gas chromatography. An automatic greaseless fraction collector is also described.

524. Vapour-Phase Chromatography and the Telegrapher's Equation.

GOLAY, M. J. E.

Presented at 129th Meeting, A.C.S., Dallas, Texas, April 1956. Abstracts p. 15B No. 40.

Explains the method of derivation of this equation and its use in the plotting of theoretical elution curves for partition columns. These curves have a steep initial front and show marked 'tailing' of the terminal portion. See also the following reference.

525. Vapour-Phase Chromatography and the Telegrapher's Equation.

GOLAY, M. J. E.

Anal. Chem. **29** (6) 928-932 (1957). *Chem. Abstr.* **51** 12598 (1957).

A review of the mathematical relationship between an electrical transmission line and a vapour-phase chromatography column. It is shown that the sample concentration within the mobile or static phase is the analog, not of voltage or current in the transmission line, but of a linear combination of these. Several conclusions, such as the existence of an optimum carrier gas flow rate, are derived from the simple theory established.

526. A Performance Index for Gas Chromatographic Columns.

GOLAY, M. J. E.

Nature **180** (4583) 435-436 (1957). *Chem. Abstr.* **52** 805 (1958).

A theoretical discussion of column operation. An expression relating band width at mid-height, the time interval between injection and the centre of the 'air-peak', the pressure drop across the column, and the time interval between injection and the centre of the band is suggested for use as a performance index.

527. Theory and Practice of Gas-Liquid Partition Chromatography with Coated Capillaries.

GOLAY, M. J. E.

Gas Chromatography. Instr. Soc. Am. Symposium—August 1957.

Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 1-11. Discussion 11-13.

A description and discussion of the development and theoretical considerations in the use of capillary columns for gas-liquid partition chromatography.

528. Gas Chromatographic Terms and Definitions.

GOLAY, M. J. E.

Nature **182** (4643) 1146-1147 (1958). *Chem. Abstr.* **53** 6867 (1959).

A discussion on the ambiguous meaning of height equivalent to a theoretical plate, and the impossibility of drawing precise conclusions about the resolution of a column from a knowledge of the number of theoretical plates.

529. Theory of Chromatography in Open and Coated Tubular Columns with Round and Rectangular Cross-Sections.

GOLAY, M. J. E.

Gas Chromatography 1958. Amsterdam Symposium—May 1958.

Ed. DESTY, D. H. Published by Butterworths 1958. 36-53. Author's additional comments 53-55.

The theory of capillary columns. Discusses the general problem of diffusion

- in a flow stream, and the 2 processes of static and dynamic diffusion; diffusion in a round or flat tubular column, the specific performance index and the effect of a finite diffusion time in the fixed phase.
- 530.** Identification of Aromatic Types in a Heavily Cracked Gas Oil.
GORDON, R. J. and MOORE, R. J.
Presented at Conf. on Anal. Chem. and Appl. Spectroscopy, Pittsburgh, March 1957.
No further details are available.
- 531.** Identification of the Products in the Radiolysis of Liquid Benzene.
GORDON, S., DYKEN, A. R. van and DOUMANI, T. F.
J. Phys. Chem. **62** 20-24 (1958). *Chem. Abstr.* **52** 7877 (1958).
The products were separated on a column of didecylphthalate at 160-182°C, and identified by mass spectrometry. Calibration chromatograms were prepared from diphenyl, phenylcyclohexane and dicyclohexyl.
- 532.** Evidence on Mechanisms of Halogen and Tritium Recoil Labelling Reactions.
GORDUS, A. A., SAUER, M. C. and WILLARD, J. E.
J. Am. Chem. Soc. **79** 3284-3285 (1957). *Chem. Abstr.* **51** 14428 (1957).
A column of silica gel, 12 ft × 4 mm, was used to separate the products of the reaction of gaseous alkanes with tritons from the $\text{He}^3(n,p)\text{H}^3$ reaction. The technique used has been given by Evans and Willard, and a flow proportional counter was used to detect radioactive components.
- 533.** Chemical Effects of Nuclear Transformations in the Gas Phase.
GORDUS, A. A., QUINLAN, J. E., EVANS, J. B., SAUER, M. C. and WILLARD, J. E.
Presented at 132nd Meeting, A.C.S. New York, September 1957. Abstract p. 1S No. 3.
The products of reaction were investigated using gas chromatography, but no details are given in the abstract.
- 534.** Gas-Phase Reactions Activated by Nuclear Processes.
GORDUS, A. A. and WILLARD, J. E.
J. Am. Chem. Soc. **79** 4609-4616 (1957). *Chem. Abstr.* **51** 17468 (1957).
The application of gas chromatography to the analysis of mixtures of tracer amounts of radioactive materials is illustrated in this paper.
- 535.** Hydrocarbon Separation.
GORIN, E.
U.S. 2,759,915 (1956). *Chem. Abstr.* **51** 3980 (1957).
Separation is achieved by means of urea-complex formation.
- 536.** An Adsorption Theory of Gas Chromatography.
GRAF, L. and TOTH, J.
Acta Chim. Acad. Sci. Hung. **13** (13/4) 403-428 (1958). *Chem. Abstr.* **52** 14281 (1958).
A theory of elution and frontal gas chromatography is developed, and an equation given for correlation between the 2 methods. Conditions determining the possibility of separation of 2 gases by elution are expressed mathematically.
- 537.** Theory of the Chromatographic Analysis of Hydrocarbon Gases.
GRAF, L., TOTH, J. and GONCZ, I.
Magyar Kem. Folyoirat **62** 113-118 (1956). *Chem. Abstr.* **52** 4413 (1958).
A theoretical and experimental study of the analysis of gases by adsorption chromatography. The adsorptive capability of an adsorbent may be deduced from the results of this study.

538. Gas Chromatography.

GRAMSTAD, T.

Tidsskr. Kjemi, Bergvesen Met. **18** 81-91 (1958). *Chem. Abstr.* **52** 13363 (1958).

Gives a comprehensive review of the theory and practice of gas chromatography, with details of the development, construction and use of an apparatus.

539. An Emissivity Detector for Gas Chromatography.

GRANT, D. W.

Gas Chromatography 1958. *Amsterdam Symposium—May 1958.**Ed. DESTY, D. H. Published by Butterworths* 1958. 153-163. *Discussion* 163-164.

A new method of detection consists of mixing coal gas with the exit chromatographic gas stream and combusting the mixture at a wide stainless steel jet. The emissivity of the flame is measured by means of an optical condensing system and photo cell.

540. A Consideration of Factors Governing the Separation of Substances by Gas-Liquid Partition Chromatography.

GRANT, D. W. and VAUGHAN, G. A.

J. Appl. Chem. (London) **6** (4) 145-153 (1956). *Chem. Abstr.* **51** 801 (1957).

A simple theoretical treatment has been evolved from which optimum operating conditions and column dimensions can be calculated to effect separations of chemically similar compounds. A discussion is also given on the effect of some of the operating variables on column efficiency.

541. The Use of Gas-Liquid Chromatography in the Determination of the Distribution of Aromatic Compounds in Coal Tar Naphthas.

GRANT, D. W. and VAUGHAN, G. A.

I.P. Symposium, London, 1956. 413-421.*Ed. DESTY, D. H. Published by Butterworths* 1957.

The problem of separating paraffins from aromatic compounds of similar boiling points and also of determining the important compounds indene and coumarone have been largely overcome by the use of tricresyl phosphate as stationary phase in the analysis of coal tar naphthas.

542. New Analytical Techniques for the Measurement of Hydrocarbon Gases in Drilling Muds.

GRAY, F. B.

Presented at 8th Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, March 1957. Abstract in Appl. Spectroscopy **11** (2) 102 (1957).

Describes an investigation into the use of i.r. plant stream analysers, mass spectrometers and gas chromatography for the measurement and identification of hydrocarbon gases in drilling muds. Sampling techniques have been developed and the available instrumentation has been tested under both laboratory and field conditions.

543. Hydrocarbon Measurements in Drilling Muds.

GRAY, F. B.

Proc. Natl. Conf. Instr. Methods Anal., Chicago, 1957. Paper No. A157-4-4. 4 pp. *Chem. Abstr.* **52** 14145 (1958).

See previous reference. The logging of an oil or gas well may be accomplished more accurately by the use of a plant stream i.r. analyser in conjunction with a gas chromatograph.

544. A Hydrogen-Conversion Detector for Gas Chromatography.

GREEN, G. E.

Nature **180** (4580) 295-296 (1957). *Chem. Abstr.* **52** 5050 (1958).

Compounds eluted from the column are converted to CO_2 and H_2O . The usual method of detection is CO_2 by i.r. or by thermal conductivity after removal of H_2O . This paper describes a method of converting $\text{H}_2\text{O} \rightarrow \text{H}_2$, removing CO_2 , and detecting the H_2 by thermal conductivity.

545. Vapour-Phase Chromatography.

GREEN, S. W.

Ind. Chemist. **32** (372) 24-28 (1956). *Chem. Abstr.* **50** 6137 (1956).

The author describes the various types of vapour-phase chromatography, the underlying principles, and the relevant apparatus. After outlining recent developments, he compares the adsorption and partition methods. 26 references are given.

546. The Quantitative Analysis of Mixtures of Chlorofluoromethanes.

GREEN, S. W.

I.P. Symposium, London, 1956. 388-394.*Ed. DESTY, D. H. Published by Butterworths 1957.*

Gas-liquid partition chromatography was applied to the analysis of mixtures of chlorofluoromethanes and carbon tetrachloride. The column was packed with kieselguhr impregnated with dibutyl phthalate, and nitrogen was used as carrier gas.

547. The Calculation of the Limiting Retention Volume in Gas-Liquid Partition Chromatography.

GREENE, S. A.

J. Phys. Chem. **61** 702 (1957). *Chem. Abstr.* **51** 13512 (1957).

The limiting retention volume was deduced as the volume of gas phase on a uniformly packed column multiplied by the apparent retention time of the zone and divided by the apparent retention time of the carrier gas.

548. Application of Gas-Adsorption Chromatography to the Analysis of Chemical Reactions in Flow Systems.

GREENE, S. A.

J. Chem. Educ. **34** 194-195 (1957). *Chem. Abstr.* **51** 7802 (1957).

No details are given in *Chem. Abstr.* A short article which gives a schematic diagram of the apparatus used, and chromatograms showing the separation of the reaction products of carbon and air on charcoal, and the separation of the decomposition products of acetone and *n*-pentane on alumina.

549. The Separation of the Rare Gases by Gas-Solid Chromatography.

GREENE, S. A.

Advances in Gas Chromatography, A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D-105. (Presented during 132nd Meeting, A.C.S.)

The use of the following adsorbents is briefly described: activated carbon, silica gel and Linde Molecular Sieve Type 5A.

550. The Determination of Heats of Adsorption by Gas-Solid Chromatography.

GREENE, S. A. and PUST, H.

J. Phys. Chem. **62** 55-58 (1958). *Chem. Abstr.* **52** 7809 (1958).

An equation is deduced for the retention time of the zone, and was used for the determination of heats of adsorption. Heats of adsorption

determined on charcoal, alumina and silica gel agreed well with those determined by other methods.

- 551.** Use of Silica Gel and Alumina in Gas-Adsorption Chromatography.
GREENE, S. A. and PUST, H.
Anal. Chem. **29** (7) 1055 (1957). *Chem. Abstr.* **51** 14371 (1957).
The 2 adsorbents were compared by analysing a complex gas mixture. The adsorbents are generally similar, although alumina is superior for light hydrocarbon analysis.
- 552.** The Analysis of Nitrogen Dioxide by Gas-Solid Chromatography.
GREENE, S. A. and PUST, H.
Advances in Gas Chromatography—A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D-107 to D-109. (Presented during 132nd Meeting, A.C.S.)
The use of Linde Molecular Sieve 5A for the analysis of nitrogen dioxide is described, with helium as carrier gas at a column temperature of 23°C. See the following reference.
- 553.** Determination of Nitrogen Dioxide by Gas-Solid Chromatography.
GREENE, S. A. and PUST, H.
Anal. Chem. **30** (6) 1039-1040 (1958). *Chem. Abstr.* **52** 14417 (1958).
Nitrogen dioxide is rapidly converted to nitric oxide by the water adsorbed on a Linde Molecular sieve column. The resultant wave form is indistinguishable from that of pure nitric oxide.
- 554.** Effect of Different Carrier Gases on Retention Times in Gas-Adsorption Chromatography.
GREENE, S. A. and ROY, H. E.
Anal. Chem. **29** (4) 569-570 (1957). *Chem. Abstr.* **51** 10177 (1957).
Retention times on the same column are markedly affected by different carrier gases. A carrier gas which is adsorbed to any extent, will occupy the more active adsorption sites, thus reducing the retention time. An analogy to this is shown in liquid partition chromatography where different solvents are used to effect a separation.
- 555.** Separation of Gases by Gas-Adsorption Chromatography.
GREENE, S. A., MÖBERG, M. L. and WILSON, E. M.
Anal. Chem. **28** (9) 1369-1370 (1956). *Chem. Abstr.* **50** 16531 (1956).
The separation of some low boiling gases and hydrocarbons was investigated by gas-adsorption chromatography using columns of activated charcoal and alumina which were continuously heated during elution. It was found that this method sharpens peaks, improves peak symmetry and reduces analysis times.
- 556.** A Mercury Cut-Off for Transferring Gas at Atmospheric Pressure into a High Vacuum.
GREENWOOD, N. N.
J. Sci. Instr. **33** (8) 318-319 (1956). *Chem. Abstr.* **51** 2 (1957).
This device allows the transfer of gas in either direction across a pressure differential from 0 to 800 mm Hg without any loss of pumping speed or the use of large amounts of Hg.
- 557.** The Adsorption of Hydrocarbon Vapours by Ammonium Phosphomolybdate.
GREGG, S. J. and STOCK, R.
Trans. Faraday Soc. **53** (10) 1355-1362 (1957). *Chem. Abstr.* **52** 11516 (1958).
This study was originally undertaken in order to test the usefulness of

the solid as an adsorbent in gas chromatography, but the investigation was extended to cover hydrocarbons from methane to nonane, isopentane, benzene, carbon tetrachloride, ammonia, water and nitrogen.

558. Sorption Isotherms and Chromatographic Behaviour of Vapours.

GREGG, S. J. and STOCK, R.

Gas Chromatography 1958. *Amsterdam Symposium—May 1958.*

Ed. DESTY, D. H. Published by Butterworths 1958. 90-98.

Adsorbed water has been found to affect the adsorption isotherms of the hydrocarbon vapours markedly, and with cyclohexane on calcium carbonate actually changed the isotherm from a Type II to Type III with a corresponding change in the chromatographic behaviour.

559. The Chromatography of Gases and Vapours. IV. Applications of the Surface-Potential Detector.

GRIFFITHS, J. H. and PHILLIPS, C. S. G.

J. Chem. Soc. 1954 3446-3453. *Chem. Abstr.* **49** 2125 (1955).

The paper describes a device for the detection and estimation of vapours in nitrogen. Its action depends upon changes in the surface potential difference between 2 metal plates, 1 of which is vibrating close to the other. Its application to gas chromatography is discussed and illustrated. It has also been used to determine vapour pressures.

560. Gas Chromatography.

GRIFFITHS, J. H., JAMES, D. J. and PHILLIPS, C. S. G.

Analyst **77** (921) 897-904 (1952). *Chem. Abstr.* **47** 1530 (1953).

Recent work is described and examples given of the separation and analysis of volatile organic mixtures by displacement chromatography from charcoal columns at 100°C. The use of partition columns is also described, and the various methods of detection discussed. These include thermal conductivity, flow impedance, dielectric constant and surface-potential detectors.

561. Testing Tubes as Detectors for Gas Chromatography.

GROSSKOPF, K.

Erdöl u Kohle **11** 304-306 (1958). *Chem. Abstr.* **52** 15321 (1958).

A simplified apparatus has been used in conjunction with a testing tube technique originally evolved for the testing of industrial atmospheres.

562. Study of Adsorbent Surfaces by Means of Xenon Isotopes.

GROTH, W. and HARTECK, P.

Naturwissenschaften **29** 535-536 (1941). *Chem. Abstr.* **37** 2634 (1943).

A description of experiments using activated carbon and silica gel.

563. Development of a Continuous Gas Chromatographic Analyser for Sludge Digestion Studies.

GRUNE, W. N., CARTER, J. V. and KEENAN, J. P.

Sewage Industr. Wastes **28** (12) 1433-1442 (1956). *Chem. Abstr.* **51** 3067 (1957).

Gas streams are continuously sampled using an automatically controlled gas sampling valve which passes the sample into a carrier gas stream of helium or nitrogen. A thermal conductivity cell is the basic analyser.

564. The Analysis of Light Hydrocarbon Gases by Fractional Adsorption.

GUILD, L. V.

Proc. 32nd Annual Convention Natural Gasoline Assn. of America, 1953.

This paper describes an instrument and method suitable for the analysis of light hydrocarbon gases through pentanes.

- 565.** The Analysis of Liquefied Petroleum Gases by Fractional Adsorption.
GUILD, L. V.
Presented at Symposium on Methods for Testing Liquefied Petroleum gases, St. Louis, September 1954.
The principle of the method is the actual physical separation of the gases based on their preferential adsorption on a highly activated charcoal-type adsorbent, and their identification by thermal conductivity.
- 566.** Some Practical Applications of Gas Chromatography.
GUILD, L. V.
Presented at Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, February 1956.
This paper described the following:—(a) analysis of a C_4 cut, (b) determination of impurities in commercial propane and butane, (c) analysis of a mixture of C_5 and C_6 paraffins, (d) determination of N_2 in natural gas, and (e) analysis of a mixture containing C_4 – C_8 hydrocarbons.
- 567.** Some Applications of the Elution and Displacement Techniques in Gas-Vapour Chromatography.
GUILD, L. V.
Presented at 129th National A.C.S. Meeting, Dallas, Texas, April 1956. Abstracts p. 16B No. 45.
The use of elution analysis with both solid adsorbents and with partition liquids is considered with respect to the types of samples most suited to each technique. Displacement analysis by fractional adsorption is also considered and the 2 methods are compared in cases where their application overlaps.
- 568.** Gas Chromatography: Operating Conditions and Technique.
GUILD, L. V.
Presented at 31st Ann. Meeting, California Nat. Gas Assn., Los Angeles, November 1956. Reported in Oil Gas J. 54 (85) 134, 136 (1956).
A discussion of operating variables, including column size and temperature, eluent gas and sample size, and methods of interpreting the results obtained.
- 569.** Techniques and Instrumentation for Microanalysis by Gas Chromatography.
GUILD, L. V.
Presented at 11th Ann. Microchem. Symposium, New York, March 1956. Abstract in Anal. Chem. 28 (5) 921 (1956).
Described the technique and instrumentation necessary, specific applications and results being used as illustrations.
- 570.** Base Line Control in Gas-Liquid Chromatography.
GUILD, L. V., BINGHAM, S. and AUL, F.
Gas Chromatography 1958. Amsterdam Symposium—May 1958. Ed. DESTY, D. H. Published by Butterworths 1958. 226–241. Discussion 241–247.
Four variables are discussed: (a) variation in eluent pressure; (b) change in eluent flow; (c) impurities in eluent gas, and (d) stationary phase carry over. An apparatus and system are described to purify the eluent and control accurately the flow to within 1% even when the column temperature is varied over a 200°C range.

- 571.** Recent Improvements in Thermal Conductivity Measurements and New Values for Carbon Dioxide near the Critical Point.
GUILDNER, L. A.
Transport Props. in Gases. Proc. Gas Dynamics Symposium, 2nd, Evanston, 1957. 55-61. (Published 1958.) Chem. Abstr. 52 11503 (1958).
An improved coaxial cylinder type apparatus is described.
- 572.** Separation and Determination of Higher Acetylenes with Gas-Liquid Partition Chromatography.
GUNESCH, H. and STADTMULLER, R.
Rev. Chim. Bucharest 9 (1) 35-38 (1958). Chem. Abstr. 52 19712 (1958).
The analysis of mixtures of methyl-, vinyl- and ethylacetylenes and diacetylene is carried out on a column of alumina activated at 1,000°C and treated with transformer oil or dioctyl phthalate. The column is maintained at 25°C and hydrogen is used as eluting gas. Detection is by interferometer.
- 573.** Identification of Dimethyl Sulphide as the Major Volatile Constituent of the Insect Attractant, 'Staley's Protein Insecticide Bait No. 7'.
GUNTHER, F. A., BLINN, R. C. and BARNES, M. M.
Presented at 133rd Natl. Meeting A.C.S., San Francisco, April 1958. Abstract p. 24A No. 61.
Gas chromatography using several partition columns was used to separate dimethyl sulphide from the atmosphere over the attractant. The compound was identified by i.r. and mass spectrometry.
- 574.** The Combination of Physical Methods of Measurement in Chemical Analysis.
GUNZLER, H.
Presented at Meeting on 'The Analysis of Gaseous and Liquid Hydrocarbons and their Derivatives by Physical Methods'. Essen, January 1958. Printed in Z. anal. Chem. 164 (1) 49-56 (1958).
In German. A mixture of 12 C₅ and C₆ olefins examined by u.v., i.r., mass spectrometry and by gas chromatography. The results are compared and combined.
- 575.** The Preparation of Synthetic Zeolites and their Properties of Molecular Sieves.
GUYER, A., INEICHEN, M. and GUYER, P.
Helv. Chim. Acta 40 1603-1611 (1957). Chem. Abstr. 52 2302 (1958).
The preparation of analcite-type compounds is described and their absorptive capacities tested.
- 576.** Applications of Gas Chromatography.
GYGI, R. and POTTERAT, M.
Mitt. Gebiete Lebensm. u. Hyg. 48 497-504 (1957). Chem. Abstr. 52 12649 (1958).
Applications to the determination of alcohol in various products such as lacquers, enamels and spirits are described.
- 577.** Gamma Irradiation of Some Organic Compounds Dissolved in Anhydrous Hydrogen Fluoride.
HADLEY, E. H., ADAMS, R. M. and KATZ, J. J.
Presented at 133rd Meeting A.C.S., San Francisco, April 1958. Abstract p. 37Q No. 91.
Irradiation was carried out on solutions of ethanol, acetic acid and trifluoroacetic acid using a Cobalt-60 source. Gases evolved which could not

be condensed in a carbon dioxide bath were analysed by mass spectrometry, and the condensed liquid examined by gas chromatography. No further details are given in the abstract.

578. On the Use of Coupled Columns in Chromatography.

HAGDAHL, L.

Science Tools **1** (3) 21-28 (1955). *Chem. Abstr.* **49** 5896 (1955).

In English. The blurring of eluate fronts can be minimised by the use of finely powdered adsorbents and low rates of flow, but homogenous packing is then difficult and leads to frontal deterioration. The use of coupled columns is described and discussed.

579. An Improved Microcatalytic Technique.

HALL, W. K. and EMMETT, P. H.

J. Am. Chem. Soc. **79** 2091-2093 (1957). *Chem. Abstr.* **51** 14333 (1957).

A known volume of gaseous reactants is added to a carrier gas, passed over a catalyst and then into a gas chromatography column for analysis.

580. Integrating Device for Use with Potentiometers.

HALL, W. K., SILL, G. and WOLFE, C. L.

Science **126** (3278) 821-823 (1957).

The integrating device is fully described and illustrated. It is suitable for use in gas chromatography, and has been constructed to operate in conjunction with a Leeds and Northrup Speedomax automatic recording potentiometer with a 5-millivolt scale.

581. A Simple Apparatus for Adsorption Analysis of Gases.

HAMMAR, C. G. B.

Svensk. Kem. Tid. **63** 125-135 (1951). *Chem. Abstr.* **45** 10551 (1951).

In English. Hydrocarbons are separated according to their molecular weight by selective adsorption on activated carbon. Desorption is accomplished by controlled heating of the column.

582. The Vapour Pressure of Dibutylphthalate, Dibutylsebacate, Lauric Acid and Myristic Acid.

HAMMER, E. and LYDERSEN, A. L.

Chem. Eng. Sci. **7** 66-72 (1957). *Chem. Abstr.* **52** 15169 (1958).

A new still was used to measure the vapour pressure of these compounds and the results were compared with earlier data.

583. A Device for Preparing Gas Mixtures.

HANSEN, N. R.

J. Sci. Instr. **32** (2) 75-76 (1955). *Chem. Abstr.* **49** 8635 (1955).

An apparatus is described and illustrated as a method of filling proportional counters with mixed gases. The danger of pollution of one gas by another is avoided by this device.

584. Volatile Acids of Ox Perenephric Fat.

HANSEN, R. P. and McINNIS, A. G.

Nature **173** 1093 (1954). *Chem. Abstr.* **48** 12272 (1954).

Using gas-liquid partition chromatography, a complete analysis of the C₂-C₁₀ fatty acids was carried out, and a consecutive series from C₂-C₁₀ shown to be present.

585. Studies in Gas Chromatography.

HARDY, C. J.

Ph.D. Thesis, University of Bristol, England, 1955.

A review covering theory, apparatus and application of gas chromatography up to 1955, including gas-solid chromatography on charcoal and gas-liquid

chromatography with a variety of liquid phases on Celite. The preparation of small quantities of pure materials is also described. A bibliography of 87 references is included.

586. Gas-Phase Chromatography as an Analytical Technique.

HARDY, C. J.

Presented at Meeting of Western Section, Soc. for Anal. Chem., Cardiff, November 1954. Abstract in Anal. Chem. **27** (3) 470 (1955) and also in *Analyst* **79** 726 (1954).

Described the development of gas-phase chromatography as an analytical technique, giving an outline of the basic principles, and detailed methods of analysis. The analysis of substances by gas-adsorption on charcoal was compared with their analysis by gas-liquid partition columns, and gas-phase chromatography was compared with fractional distillation, mass spectrometry and infra-red analysis.

587. Partition Chromatography: A New Diagram.

HARGREAVES, M. K.

Chem. and Ind. (London) 1957 (43) 1414-1415. *Chem. Abstr.* **52** 2464 (1958).

A diagram is given which illustrates the process of partition chromatography.

588. A New Detector for Vapour-Phase Chromatography.

HARLEY, J. and PRETORIUS, V.

Nature **178** (4544) 1244 (1956). *Chem. Abstr.* **51** 5472 (1957).

Describes a glow-discharge detector. Use is made of the fact that the voltage existing across a normal gaseous discharge is a function of the type of gas used. The detector is a small Pt disc cathode and a tungsten wire anode forming one arm of a Wheatstone bridge which is supplied with 900 V from a stabilised d.c. source. The bridge is balanced with carrier gas flowing through the detector at a pressure sufficiently low to produce a normal glow discharge. The detection limit claimed is 10^{-12} mole.

589. Flame Ionisation Detector for Gas Chromatography.

HARLEY, J., NEL, W. and PRETORIUS, V.

Nature **181** (4603) 177-178 (1958). *Chem. Abstr.* **52** 6859 (1958).

A detector has been developed which depends on the ionisation of the effluent in a hydrogen flame. Gases from the column in a suitable inert carrier are mixed with hydrogen and burned in air at the tip of a glass jet. Pt electrodes are arranged to be in contact with the flame, the spacing not being very critical. The electrical circuit consists of a balanced cathode—follower impedance transformer. With a 0-1 ma meter or recorder, full scale deflection is produced with 1 μ l of sample. The ultimate sensitivity has not yet been established. More complete details will be published later.

590. Adsorption.

HARRIS, B. L.

Ind. Eng. Chem. **48** (3) 472 (1956).

This article contains a section on chromatography developments during 1955.

591. Adsorption.

HARRIS, B. L.

Ind. Eng. Chem. **49** (3) 460-469 (1957).

Contains information on surface area and porosity studies, and a section on gas-phase chromatography. A separate section of the extensive bibliography contains 35 references to gas chromatography.

592. Activated Alumina.

HARRIS, M. R. and SING, K. S. W.

Chem. and Ind. (London) 1957 (48) 1573-1574. *Chem. Abstr.* **52** 5082 (1958).

Describes the preparation of a stable, hydrous alumina by hydrolysing aluminium isopropoxide at a benzene/water interface.

593. Vapour-Phase Chromatographic Analysis of Chlorinated Hydrocarbons and Hydrocarbon Gases.

HARRISON, G. F.

I.P. Symposium, London, 1956. 332-345.

Ed. DESTY, D. H. Published by Butterworths 1957.

The retention volumes of some 30 compounds have been determined using a number of stationary phase liquids—tricresyl phosphate, dinonyl phthalate and Silicone MS 710 are the most useful. The gas mixtures were analysed on a 25 ft column at 0°C, hydrogen being used as carrier gas.

594. The Use of Multiple Columns and Programmed Column Heating in the Analysis of Wide Boiling Range Halogenated Hydrocarbon Samples.

HARRISON, G. F., KNIGHT, P., KELLY, R. P. and HEATH, M. T. *Gas Chromatography* 1958. *Amsterdam Symposium—May* 1958.

Ed. DESTY, D. H. Published by Butterworths 1958. 216-225. *Discussion* 241-247.

An electromechanical device is outlined which allows the temperature of a column to be raised linearly and reproducibly and at varying rates. A double column unit is also described.

595. Separation of Hydrocarbons by Means of Fractional Desorption.

HARTECK, P. and SUHR, K. A.

Die Chemie **56** 120-123 (1943). *Chem. Abstr.* **37** 5227 (1943).

Experimental data are given for hydrocarbons boiling between 60 and 145°C. A number of experiments are described, and a full description of the apparatus included.

596. Chromatographic Determination of Argon in Gas Analysis.

HARVA, O. and KELTAKALLIO, A.

Suomen Kemistilahti **30B** (12) 223-224 (1957). *Chem. Abstr.* **52** 7016 (1958).

In English. Oxygen is first removed chemically as it has the same retention time as argon. The argon is then determined on a column of silica gel at 30°C, using nitrogen as carrier gas.

597. Delivering Measured Quantities of Gases and Vapours.

HARVEY, D.

B.P. 790, 364 (1958). *Chem. Abstr.* **52** 12470 (1958).

The apparatus described may be useful in gas analysis and gas chromatography.

598. Gas-Liquid Partition Chromatography.

HARVEY, D. and CHALKLEY, D. E.

Fuel (London) **34** (2) 191-200 (1955). *Chem. Abstr.* **49** 7436 (1955).

Gas chromatographic methods are reviewed, and the disadvantages of the method of adsorption followed by displacement are described. Stationary phase liquids are discussed and the applications of gas-liquid partition columns both to qualitative and quantitative analysis are explained.

599. Factors Affecting Thermal Conductivity Detectors in Vapour-Phase Partition Chromatography.

HARVEY, D. and MORGAN, G. O.

I.P. Symposium, London, 1956. 74-86.

Ed. DESTY, D. H. Published by Butterworths 1957.

The behaviour of the thermal conductivity detector is more dependant on such operating variables as the temperature of the wire and the wall of the cell than had previously been thought. Besides previously known abnormalities that arise through dissociation of dimeric molecules on the hot wire, there are changes in the conductivity of one gas relative to another, and in mixtures the thermal conductivities are not necessarily additive.

600. Vapour-Phase Partition Chromatography for Process Stream Analysis.

HARVEY, D., WHITING, D. H. and MYLROI, M. G.

In 'Automatic Measurement of Quality in Process Plants'. Proc. Soc. Inst. Technol., Swansea, September, 1957. 222-230. Published by Butterworths 1958.

The gas chromatographic technique is briefly described and full details are given of an apparatus which has operated successfully on a plant for the separation of isobutane from *n*-butane and other hydrocarbons. The advantages and disadvantages of the method as applied to process stream analysis are discussed.

601. Gas Chromatography Analysis of Constituents in the Study of Azeotropes.

HASKIN, J. F., WARREN, G. W., PRIESTLEY, L. J. and YARBOROUGH, V. A.

Advances in Gas Chromatography, A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D-135 to D-141. (Presented during 132nd Meeting A.C.S.)

The following azeotropic systems were investigated:—

(1) Ethanol/acetonitrile/triethylamine—separated on di(2-ethylhexyl) phthalate on Celite 545 at 65°C using helium as carrier gas.

(2) Water/ethanol/acetonitrile/triethylamine—separated as in (1).

(3) Methanol/acetone/methyl acetate—separated on 85% mineral oil + 15% stearic acid on Celite 545 at 50°C using helium as carrier gas.

(4) Isopropanol/methyl ethyl ketone/chloroform—separated on didecyl phthalate on Celite 545 at 60°C. Helium carrier gas.

(5) Water/butanol/butyl acetate/butyl ether—separated on a Perkin-Elmer 'B' column at 90°C.

602. Gas Chromatography. Determination of Constituents in the Study of Azeotropes.

HASKIN, J. F., WARREN, G. W., PRIESTLEY, L. J. and YARBOROUGH, V. A.

Anal. Chem. **30** (2) 217-219 (1958). *Chem. Abstr.* **52** 7945 (1958).

See previous reference for details.

603. Modern Analytical Chemistry in Relation to the Plastics Industry.

HASLAM, J.

Proc. Congr. Mod. Anal. Chem. St. Andrews, June, 1957. 132-136. Published by Heffers, Cambridge, 1958.

A brief review of some topics of interest to the plastics industry using gas-liquid chromatography. A new stationary phase—dinonyl sebacate—is

described to effect the separation of small amounts of methyl cyclohexane present adventitiously in light petroleum which also contained some benzene.

604. Gas-Liquid Chromatography in a Plastics Analytical Laboratory.

HASLAM, J. and JEFFS, A. R.

J. Appl. Chem. (London) **7** (1) 24-32 (1957). *Chem. Abstr.* **51** 14315 (1957).

Gas chromatographic methods have been applied to the general work of a plastics analytical laboratory, particular attention being paid to the detection of impurities in polymers and the identification of solvents in adhesives. Dinonyl sebacate was used instead of dinonyl phthalate as stationary phase in the determination methylcyclohexane with improved results.

605. Applications of Gas-Liquid Chromatography. The Examination of Solvents from Plastic Adhesives.

HASLAM, J. and JEFFS, A. R.

Analyst. **83** (989) 455-462 (1958). *Chem. Abstr.* **52** 19720 (1958).

The isolation of the solvent, its gas chromatographic separation on polar and non polar columns, and i.r. and chemical tests on the separated products are described.

606. The Determination of Poly(Ethyl Esters) in Methyl Methacrylate Copolymers.

HASLAM, J., HAMILTON, J. B. and JEFFS, A. R.

Analyst. **83** (983) 66 (1958). *Chem. Abstr.* **52** 9649 (1958).

The alkoxy groups in the sample are converted to their corresponding iodides which are then determined by gas chromatography on a column (6 ft $\times$ 0.25 in.) of Celite 545 impregnated with 30% dinonyl sebacate at 75°C. Nitrogen is used as carrier gas with katharometer detection.

607. Fruit and Vegetable Flavours—Techniques Employed in the Study of the Chemistry of Cabbage Flavour.

HASSELSTROM, T.

Quartermaster Food and Container Inst. Surveys Progr. Military Subsistence Problems Ser. 1 (9) 76-86 (1957). *Chem. Abstr.* **52** 2296 (1958).

Describes the use of gas chromatography and mass spectrometry in this investigation.

608. The Use of Gas Chromatography in Kinetic Studies.

HATCH, L. F.

Gas Chromatography. Instr. Soc. Am. Symposium—August 1957.

Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 105-109.

The use of gas chromatography in the analysis of reaction products is described. All the adsorption columns used were of $\frac{1}{4}$ in. copper tubing, and the adsorbents tested included carbon, Linde Molecular sieves and Curtin X₃ Universal Adsorbent. For light hydrocarbons, a 9 ft column of activated carbon was preferred, and for benzene and other aromatic hydrocarbons, a 10 ft column was packed with Curtin X₃ Adsorbent.

609. Vapour Fractometry (Gas Chromatography). II. A Powerful New Tool in Chemical Analysis.

HAUSDORFF, H. H.

I.P. Symposium, London, 1956. 377-387.

Ed. DESTY, D. H. Published by Butterworths 1957.

Gives a comparison of vapour-phase chromatography with older techniques such as i.r., mass spectrometry, Raman and u.v. spectroscopy, and gives details of quantitative methods and sampling devices.

- 610. Quantitative Methods of Gas Chromatography.**
HAUSDORFF, H. H.
Chem. Ztg. **81** (12) 392-396 (1957). *Anal. Abstr.* **5** 3976 (1958).
A review.
- 611. Gas Chromatography. I. Powerful New Tool for Chemical Analysis.**
HAUSDORFF, H. H. and BRENNER, N.
Oil Gas J. **56** 73-75 (June 30, 1958). *Chem. Abstr.* **52** 19669 (1958).
The basic principles of gas chromatography are discussed briefly.
- 612. Gas Chromatography. II. Instrumentation Techniques Play a Vital Role in Chemical Analysis by Gas Chromatography.**
HAUSDORFF, H. H. and BRENNER, N.
Oil Gas J. **56** 122-124, 126 (July 7, 1958). *Chem. Abstr.* **52** 19669 (1958).
A description and discussion on how to select the best detector, carrier gas and column packing material for any particular analysis.
- 613. Gas Chromatography. III. 6 Variables Must be Considered for Effective Gas Chromatography.**
HAUSDORFF, H. H. and BRENNER, N.
Oil Gas J. **56** 86-88 (July 21, 1958). *Chem. Abstr.* **52** 19669 (1958).
The 6 variable parameters considered are:—flow rate, pressure, temperature, column dimensions, solid support and partition liquid. An 8-component mixture is considered as an illustration.
- 614. Gas Chromatography. IV. Here are the Limits in Application for Gas Chromatography.**
HAUSDORFF, H. H. and BRENNER, N.
Oil Gas J. **56** 89-90, 93-96 (August 4, 1958). *Chem. Abstr.* **52** 19669 (1958).
The qualitative and quantitative aspects of gas chromatography are defined and trace analysis is discussed. The possibility of obtaining fundamental data from the method is outlined.
- 615. Volatile Fatty Acids in Phospholipids.**
HAWKE, J. C.
Nature **176** 882 (1955). *Chem. Abstr.* **50** 4280 (1956).
Gas chromatography has been used to identify the following volatile fatty acids in bovine muscle phospholipids:—acetic, octanoic, propionic, hexanoic, butyric, isovaleric and valeric. (Given in decreasing amounts on a molar basis.)
- 616. The Volatile Fatty Acids of Bovine-Muscle and Liver Phospholipids.**
HAWKE, J. C.
Biochem. J. **64** 311-318 (1956). *Chem. Abstr.* **51** 2143 (1957).
It has been shown by gas-liquid chromatography that muscle phospholipids contain all the normal acids from C_1 - C_8 except C_7 plus isovaleric acid. Liver phospholipids contain all the normal acids from C_1 - C_8 plus isobutyric, isovaleric and α -methyl butyric acids.
- 617. Fatty Acids of Butterfat and the Volatile Acids Formed on Oxidation.**
HAWKE, J. C.
J. Dairy Research **24** (3) 366-371 (1957). *Chem. Abstr.* **52** 15772 (1958).
Gas-liquid chromatography was used to separate and estimate the volatile fatty acids.

- 618.** Separation of Fatty Esters and Aldehydes by Gas-Liquid Chromatography.
HAWKE, J. C., DUNKLEY, W. L. and HOOKER, C. N.
N.Z. J. Sci. Tech. **38B** (9) 925-938 (1957). *Anal. Abstr.* **5** 1896 (1958).
Normal and branched chain fatty acid esters up to C_{20} were determined quantitatively by measuring peak areas. The construction of a simple apparatus, including a thermal conductivity detector, is described.
- 619.** The Construction of an Apparatus for Studies in Vapour-Phase Chromatography at Temperatures up to 300°C.
HAWKES, J. C.
I.P. Symposium, London, 1956. 266-276.
Ed. DESTY, D. H. Published by Butterworths 1957.
An apparatus using the Martin gas density balance is described in detail. Partition columns and detector are mounted in a vapour jacket, suitable for temperatures up to 300°C. The use of the method is illustrated by an example.
- 620.** The Application of Gas Chromatography to Works Control Routine Testing.
HAWKINS, L. H. C.
Presented at Meeting of Soc. Chem. Ind., January 1957. Reported in Chem. and Ind. (London) 1957 (27) 950.
The practical aspects only are discussed, and a demonstration of Janak's original apparatus was given.
- 621.** Exhaust Gas Analysis by Gas Chromatography Combined with Infra-Red Detection.
HEATON, W. B. and WENTWORTH, J. T.
Presented at Meeting of Soc. Chem. Ind., January 1957. Reported in 1958. Abstract p. 4P No. 10. Printed in A.C.S. (General Papers) 3 (1) 81-96 (1958).
The products are combusted to give carbon dioxide which is detected using i.r. The main difficulty is removing CO from the feed without removing hydrocarbons. The limit of detection is ca 1 ppm. It was concluded that the hydrocarbon composition of the exhaust gas is dependent on the composition of the fuel.
- 622.** Exhaust Gas Analysis by Gas Chromatography Combined with Infra-Red Detection.
HEATON, W. B. and WENTWORTH, J. T.
Presented at 6th Anachem. Conf. Detroit, October 1958.
See previous abstract.
- 623.** Molar or Weight Percentage Data in Quantitative Analysis by the Thermal Conductivity Method.
HEFT, C. H.
Presented at Symposium on Gas Chromatography, Leipzig, October 1958. Preprints 59-85.
In German. The study arises from the separation of long chain C_{12} - C_{25} fatty acids and C_{18} - C_{29} paraffins. The mol and weight % interpretation of chromatograms obtained with a thermal conductivity cell are compared on the basis of a thermal balance.
- 624.** Simplified Mathematical Treatment of the Theory of Partition Chromatography.
HEFTMANN, E.
Chromatog. Methods **2** (1) 5-8 (1957). *Chem. Abstr.* **51** 10293 (1957).
An address. No further details are given in *Chem. Abstr.*

- 625.** Programme-Controlled Gas Chromatography for Preparative Separation of Organic Compounds. I.
HEILBRONNER, E., KOVATS, E. and SIMON, W.
Helv. Chim. Acta **40** 2410-2420 (1957). *Chem. Abstr.* **52** 5891 (1958).
In German with an English summary. The requirements for a fully automatic apparatus are listed and the technique of operation is described.
- 626.** Gas Chromatography of C_2 to C_{11} Fatty Acids with Simplified Apparatus.
HEINES, V., JUHASZ, R., O'LEARY, M. A. and SCHRAMM, G.
Trans. Kentucky Acad. Sci. **18** 1-7 (1957). *Chem. Abstr.* **52** 1689 (1958).
The analysis was carried out on a column (5 ft $\times$ 6 mm) packed with Hyflo-Supercel containing Dow Corning BB 148 silicone with 10% stearic acid, and surrounded by a glass jacket. The carrier gas was nitrogen, and detection was by means of a titration cell.
- 627.** Biosynthesis of Fatty Acids in Cell Free Preparations. IV.
HELE, P., POPJAK, G. and LAURYSSSENS, M.
Biochem. J. **65** 348-363 (1957). *Chem. Abstr.* **51** 6722 (1957).
The separation of butyric, crotonic (trans-but-2-enoic), hexanoic and octanoic acids by gas chromatography is mentioned.
- 628.** Separation of Isomeric Polyphenyls by Adsorption Chromatography.
HELLMAN, M., ALEXANDER, R. L. and COYLE, C. F.
Anal. Chem. **30** 1206-1210 (1958). *Chem. Abstr.* **52** 15346 (1958).
The behaviour of these compounds was studied, and was found to be related to their structure. Alumina, fuller's earth, silica gel and various grades of charcoal were used in the investigation, known mixtures being analysed by the elution technique.
- 629.** The Practical Design of a Vapour Fractometer for Automatic Multi-component Analysis of Process Streams.
HELMS, C. C. and CLAUDY, H. N.
Gas Chromatography. Instr. Soc. Am. Symposium—August 1957.
Ed. COATES, V. J., NOBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 269-279.
A description of the general design criteria which are common to all instruments, and full details of the Perkin-Elmer Model 184 Process Vapour Fractometer. The analyser, including sampling valve assembly, programmer and recorder are all dealt with separately and in detail.
- 630.** Evaluation of an Experimental Process Vapour Fractometer.
HELMS, C. C. and NOREM, S. D.
Presented at 8th Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, March 1957. Abstract in Appl. Spectroscopy **11** (2) 101 (1957).
A full description of a process monitoring instrument, including a detailed discussion of several plant applications. Quantitative performance data are presented.
- 631.** Vapour-Phase Chromatography.
HELMS, C. C. and NOREM, S. D.
Oil Gas J. **55** (17) 146-149 (1957). *Chem. Abstr.* **51** 13367 (1957).
The column used for C_2 through C_5 mixtures of olefins and paraffins was dimethylsulpholane supported on firebrick in series with a Perkin-Elmer 'B' column. The analysis was controlled by a programming unit, the carrier gas was helium, and detection by means of a thermistor thermal conductivity cell.

- 632.** The Micro-Flame Detector in Gas-Liquid Partition Chromatography: Correlation of Response with Heats of Combustion.
HENDERSON, J. I. and KNOX, J. H.
J. Chem. Soc. 1956 2299-2302. *Chem. Abstr.* **50** 15134 (1956).
Nitrogen or carbon dioxide is used as carrier gas, and hydrogen is injected into the gas stream as it emerges from the column. The resulting mixture is burnt in a draught-free housing in contact with a thermocouple. The temperature rise in the thermocouple during the combustion of any separated component is directly proportional to the rate of liberation of heat during the combustion of that component.
- 633.** The Separation of Mixtures of Biphenyl, Cyclohexylbenzene, and Bicyclohexyl by Vapour-Phase Chromatography.
HENDRIKS, W. J., SOEMANTRI, R. M. and WATERMAN, H. I.
J. Inst. Petrol. **43** 288-291 (1957). *Chem. Abstr.* **52** 708 (1958).
These compounds were separated on columns of either dioctylphthalate on firebrick or Silicone 702 on Celite at a temperature of 180-190°C, using nitrogen as carrier gas. The separation of a mixture containing the title compounds and naphthalene, Tetralin and Decalin is illustrated.
- 634.** Gas Analysis by Desorption.
HENJES, R.
Oel, Kohle, Erdoel, Teer **14** 1079-1085 (1938). *Chem. Abstr.* **33** 7991 (1939).
The analysis of fuel gas, based on the relative desorption temperatures of the components from activated carbon, is described briefly.
- 635.** Gas Adsorption on Heterogeneous Surfaces.
HEPLER, L. G.
J. Chem. Phys. **23** (11) 2110-2111 (1955). *Chem. Abstr.* **50** 3839 (1956).
The adsorption of a gas on a non-uniform surface was investigated by a mathematical treatment, and the physical significance of the limits for the integration of the isotherm equation were discussed.
- 636.** The Thermodynamics of Gas-Liquid Chromatography.
HERINGTON, E. F. G.
I.P. Symposium, London, 1956. 5-14.
Ed. DESTY, D. H. Published by Butterworths 1957.
Gas chromatography is considered as a particular example of extractive distillation. Considering the case of the separation of a binary mixture, an equation is deduced showing the relationship between the relative retention volumes, the vapour pressures and the activity coefficients of the components on a definite stationary phase.
- 637.** A Simple Thermal Conductivity Meter for Gas Analysis with Special Reference to Fumigation Problems.
HESELTINE, H. K., PEARSON, J. D. and WAINMAN, H.
Chem. and Ind. (London) 1958 (40) 1287-1288. *Chem. Abstr.* **53** 6511 (1959).
Describes the construction and use of an instrument for detecting methyl bromide in air. 'The instrument can obviously be used in many other fields . . .', state the authors.
- 638.** The Rate Factor of Adsorption Processes in Chromatographic Columns.
HESSE, G.
Z. Elektrochem. **55** (1) 60-65 (1951). *Chem. Abstr.* **45** 9335 (1951).
A mixture of benzene, *o*-, *p*- and *m*-xylenes, and ethyl benzene was separated by adsorption chromatography on various adsorbents at 156°C using

hydrogen as carrier gas. Activated carbon and silica gel (classed as the 'best adsorbents'), did not always give the best separations, as adsorption was only completed very slowly, and part of the adsorbate became irreversibly bound. The adsorptive capacities of various adsorbents for *o*-xylene were determined.

639. Adsorption Analysis of Gases and Vapours.

HESSE, G. and TSCHACHOTIN, B.

Naturwissenschaften **30** 387-392 (1942). *Chem. Abstr.* **37** 6211 (1943).

The gas or vapour was mixed with a carrier gas (hydrogen was found to be the most suitable) and passed into a heated adsorption column containing silica gel. This method has been applied to the separation of benzene/cyclohexane and benzene/carbon tetrachloride mixtures. It was pointed out that the temperature of the adsorbent should be as low as possible.

640. Experience Indicates Chromatography is a Plant Workhorse.

HICKERSON, J. F.

Oil Gas J. **56** (16) 119-120 (1958). *Chem. Abstr.* **52** 15883 (1958).

A description of the laboratory operation of 4 chromatographs. The main partition liquids used are benzyl Cellosolve and Octoil. The procedures and operating details are given.

641. An Empirical Method for Converting Gas Chromatographic Elution Areas to Concentrations.

HINKLE, E. A. and JOHNSEN, S. E. J.

Gas Chromatography. Instr. Soc. Am. Symposium—August 1957.

Ed. COATES, V. J., NOBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 25-30.

The integrated elution areas were obtained with a compensating polar planimeter and an equation is given for their conversion to component mole concentrations. Details of the experimental work carried out are included.

642. Temperature Effects in Gas-Phase Partition Chromatography.

HOARE, M. R. and PURNELL, J. H.

Research Correspondence, Suppl. to Research (London) **8** (8) S41-S42 (1955). *Chem. Abstr.* **49** 15362 (1955).

A preliminary communication showing that there is a connection between the elution time of a component and its vapour pressure under the operating conditions described. See the following reference.

643. Temperature Effects in Gas-Liquid Partition Chromatography.

HOARE, M. R. and PURNELL, J. H.

Trans. Faraday Soc. **52** (2) 222-229 (1956). *Chem. Abstr.* **50** 14311 (1956).

A logarithmic relation is shown to exist between the peak retention volume of a substance and its vapour pressure at the elution temperature. For certain related compounds, a plot of these quantities gives a single straight line. The application of this relation to the measurement of physical properties is discussed, and also its usefulness in relation to analytical problems.

644. Gas-Liquid Chromatography and its Application to Paint and Allied Industries.

HODDEN, F. W.

J. Oil and Colour Chemists Assoc. **41** (1) 24-41 (1958). *Chem. Abstr.* **53** 8657 (1959).

The technique has been applied to the analysis of solvent mixtures, resin solutions and aqueous solvents, and to the identification of polymers.

645. On the Theory of Chromatography. II.

HOEK, A. van den and SMIT, W. M.

Rec. trav. chim. **76** 577-589 (1957). *Chem. Abstr.* **51** 15216 (1957).

See also the paper by Smit and van den Hoek, reported later, which is part I. A theory, with experimental verification, of the separation of hexane/chloroform and hexane/carbon tetrachloride mixtures on columns of silica gel.

646. Analysis in Technical Mixtures of Solvents which are Injurious to Health. Comparative Analysis of the Application of Infra-Red Spectroscopy and Gas Chromatography.

HOFFMAN, E. G., JONG, B. de, SCHNEIDER, K. and SCHOMBURG, G.

Presented at Meeting on 'The Analysis of Gaseous and Liquid Hydrocarbons and their Derivatives by Physical Methods'. Essen, January 1958. Printed in Z Anal. Chem. **164** (1) 182-218 (1958).

In German. Samples of solvents have been analysed by i.r. spectroscopy and gas chromatography. Results are given for 12 test mixtures. 20 references are appended.

647. Performance of Technical Apparatus for Gas Absorption.

HOFTYZER, P. J.

Joint Symposium Scaling-up Chem. Plant and Processes, London 1957. 53-57. *Chem. Abstr.* **52** 1692 (1958).

It is emphasised that the scaling-up of even 1 parameter can completely change the operating characteristics and efficiency of an adsorption apparatus. Many causes can contribute to loss in efficiency, and an accurate prediction of performance can only be obtained if sufficient experimental data is available.

648. Oscillographic Mass Spectrometric Monitoring of Gas Chromatography.

HOLMES, J. C. and MORRELL, F. A.

Appl. Spectroscopy **11** (2) 86-87 (1957). *Chem. Abstr.* **51** 14329 (1957).

The effluent from a gas chromatography column may be monitored continuously with a mass spectrometer and an oscilloscope. The method of operation is described, and the applications of the apparatus are outlined.

649. Adsorption Studies on a Series of Heat-Treated Shawinigan Acetylene Carbon Blacks.

HOLMES, J. M. and BEEBE, R. A.

Can. J. Chem. **35** 1542-1544 (1957). *Chem. Abstr.* **52** 15186 (1958).

Adsorption isotherms for nitrogen, sulphur dioxide, carbon dioxide and ammonia are given.

650. Gas Chromatographic Trace Analysis on a Synthesis Gas.

HOLZHAUSER, H.

Presented at Symposium on Gas Chromatography, Leipzig, October 1958. Preprints 86-122.

In German. Using a thermal conductivity cell, the lower hydrocarbons present as impurities in Fischer-Tropsch synthesis gas are determined either directly or after enrichment by adsorption and subsequent desorption from active carbon. By the latter procedure, as low as 10^{-4} vol% impurity can be determined.

651. The Automatisisation of Gas Chromatography.

HOOIMEIJER, J., KWANTES, A. and CRAATS, F. van de.

Gas Chromatography 1958. *Amsterdam Symposium—May 1958.*

Ed. DESTY, D. H. Published by Butterworths 1958. 288-297. *Discussion* 297-299.

The requirements to be fulfilled by automatised equipment have been established. Special attention was devoted to the development of apparatus that, at regular intervals, introduces gaseous samples of reproducible size. It consists of a compact system of pneumatically operated diaphragm valves and a cycle timer.

652. Gas Chromatography.

HORN, O., SCHWENK, U. and HACHENBERG, H.

Brennstoff-Chem. **38** 116-120 (1957). *Chem. Abstr.* **51** 10177 (1957).

A commercial instrument for use with Janak's method is described, and the principles of the gas chromatographic method are discussed.

653. Gas Chromatography. II. Application to Gas Separation in the Industrial Laboratory.

HORN, O., SCHWENK, U. and HACHENBERG, H.

Brennstoff-Chem. **39** 336-346 (1958). *Chem. Abstr.* **53** 3973 (1959).

Hydrocarbon mixtures of up to 30 components were analysed. Each can be determined over the range 0.01-99.8 vol%. An apparatus with 4 exchangeable columns and thermal conductivity detection is described, and an example is given of a rapid evaluation method which enables a 30 component mixture to be analysed within 3 hours.

654. A Theory for Industrial Gas-Liquid Chromatographic Columns.

HOUSTON, R. H.

U.S. Atomic Energy Comm. UCRL-3817 171 pp. (1958). *Chem. Abstr.* **52** 14242 (1958).

Theoretical considerations in the design and operation of large-scale columns are discussed, and the mathematical model resulting was tested experimentally on a laboratory scale. A longer abstract is given in *Chem. Abstr.*

655. New Approach to the Analysis of Hop Oil.

HOWARD, G. A.

J. Inst. Brewing **62** (2) 158-159 (1956). *Anal. Abstr.* **4** 698 (1957).

Using gas-liquid partition chromatography, 18 components of hop oil have been separated. The presence of other highly volatile components is not excluded.

656. Hydrocarbons of the Essential Oil of Hops.

HOWARD, G. A. and SLATER, C. A.

Chem. and Ind. (London) 1957 (16) 495-496. *Chem. Abstr.* **51** 14207 (1957).

These hydrocarbons have been studied on a 4 ft column of Apiezon M grease at 170°C using nitrogen as carrier gas.

657. Evaluation of Hops: New Approach to the Detailed Analysis of Hop Resins.

HOWARD, G. A. and TATCHELL, A. R.

J. Inst. Brewing **62** (1) 20-27 (1956). *Anal. Abstr.* **3** 2298 (1956).

Gas-liquid partition chromatography was used to determine the mixture of fatty acids obtained by oxidising the α -soft resin of hops.

- 658.** The Properties of Gas-Liquid Columns used with an Active Carrier.
HRAPIA, H.
Presented at the Symposium on Gas Chromatography, Leipzig, October 1958. Preprints 123-143.
In German. Variation of quantity of liquid phase on liquid modified adsorbents (silica gel and alumina) was investigated with respect to retention volume and column efficiency.
- 659.** A New Recording Integral Detector Based on Janek's Principle.
HRAPIA, H.
Presented at the Symposium on Gas Chromatography, Leipzig, October 1958. Preprints 144-154.
In German. The apparatus is described.
- 660.** Composition of Automotive Engine Exhaust. Analytical Methods.
HUGHES, K. J., ELLIS, C. F. and HURN, R. W.
Presented at 131st Nat. Meeting A.C.S. Miami, Florida, April 1957. Abstracts p. 11Q No. 35.
The wide range of materials found in exhaust gases has been analysed by gas chromatography, mass spectrometry and i.r. techniques. No details given in the abstract.
- 661.** Volatile Amines of Herring Flesh.
HUGHES, R. B.
Nature **181** 1281-1282 (1958). *Chem. Abstr.* **52** 18950 (1958).
Gas chromatography affords a rapid method for the specific identification and estimation of volatile amines which are produced in fish flesh. The method of James, Martin and Smith was used in their analysis.
- 662.** Gas-Liquid Chromatography.
HULL, W. Q.
Ind. Eng. Chem. **47** (10) 13A (1955).
A description of the apparatus used by Martin and James at the National Institute for Medical Research, London, and a general review of the subject.
- 663.** Diatomaceous Earth.
HULL, W. Q., KEEL, H., KENNEY, J. and GAMSON, B. W.
Ind. Eng. Chem. **45** 256-269 (1953). *Chem. Abstr.* **47** 7137 (1953).
A collaborative report covering all aspects of the material.
- 664.** Chromatography of Gases and Light Hydrocarbons.
HULTSCHIG, M.
Freiberger Forschungsh. **A80** 117-122 (1958). *Chem. Abstr.* **52** 11388 (1958).
The products of the distillation of butane were determined in a semi-automatic apparatus, using a column of alumina for highly adsorbed materials, and a column of alumina + 15% cetane for weakly adsorbed materials.
- 665.** Analysis of Gas Mixtures Containing Acetylene by Various Methods.
HUNSMANN, W.
Presented at Meeting on 'The Analysis of Gaseous and Liquid Hydrocarbons and their Derivatives by Physical Methods'. Essen, January 1958. Printed in Z. Anal. Chem. **164** (1) 57-61 (1958).
In German. Mixtures containing acetylene were analysed by mass spectrometry, gas chromatography and with an Orsat apparatus.

- 666.** Determination of Amino Acids by Ninhydrin Oxidation and Gas Chromatography. Separation of Leucine and Isoleucine.
HUNTER, I. R., DIMICK, K. P. and CORSE, J. W.
Chem. and Ind. (London) 1956 (16) 294-295. *Chem. Abstr.* **50** 12754 (1956).
Aldehydes are liberated from α -amino acids by reaction with ninhydrin, and carried to a cold trap in a stream of nitrogen. Samples for analysis by gas-liquid partition chromatography are removed from the cold trap as desired. Full experimental details are given, and the separation of leucine and isoleucine is described.
- 667.** Analysis of Automobile Engine Exhaust by Gas Chromatography.
HURN, R. W.
Presented at 5th Annual Anachem. Conf. Dearborn, Michigan, October 1957.
No further details are available.
- 668.** Application of Gas Chromatography to the Analysis of Exhaust Gas.
HURN, R. W., HUGHES, K. J. and CHASE, J. O.
Presented at S.A.E. Annual Meeting, Michigan. January 1958. Preprint 11e.
No further details are available.
- 669.** Gas Chromatography in the Plant Control Laboratory.
HYBL, C. and LHOTSKY, O.
Chem. prumysl. **7** 405-407 (1957). *Chem. Abstr.* **52** 12650 (1958).
An improved apparatus is described. 2 columns are incorporated, 1 containing an adsorbent of lower adsorptivity, and the other an adsorbent of higher adsorptivity. A novel carbon dioxide generator is also included. Alumina and activated carbon are used as adsorbents.
- 670.** The Use of Frontal Analysis in Gas-Liquid Chromatography of Radioactive and Non-Radioactive Gases.
IANOVSKY, M. I. and GAZIEV, G. A.
Doklady Akad. Nauk. S.S.S.R. **120** (4) 812-814 (1958).
Frontal analysis of mixtures of hydrocarbons was carried out on columns (1.6-16.0 m $\times$ 5 mm) packed with either dinitrophenol or nitrobenzene supported on kieselguhr, using hydrogen as carrier gas and thermal conductivity detection.
- 671.** The Qualitative and Quantitative Analysis of Fatty Acids in the Range C_1 - C_{20} .
INSULL, W. and JAMES, A. T.
Advances in Gas Chromatography—A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D-111 to D-113. (Presented during 132nd Meeting, A.C.S.)
 C_1 - C_6 acids may be analysed either as free acids or as their methyl esters. The free acids are separated on a column of silicone acid (BC 550) containing 10% by wt of stearic acid at 100° or 137°C. The acids are detected by titration. The methyl esters are resolved on a column of dioctyl phthalate at 78.7° or 100°C, and detected by any of the usual methods. The C_6 - C_{20} acids must be converted to methyl esters and can then be separated on a column of Apiezon M grease, at a temperature of at least 200°C.

672. Quantitative Determination of Certain Vapour-Phase Constituents of Cigarette Smoke.

IRBY, R. M. and HARLOW, E. S.

Presented at 133rd Natl. Meeting Am. Chem. Soc., San Francisco, April 1958. Abstract p. 9A No. 20.

The method involves the separation of the vapour-phase from the particulate phase by a glass fibre filter, the collection of the vapour-phase at liquid nitrogen temperature, a low temperature evaporative distillation of the trapped materials, and final separation and determination by means of liquid-phase partition chromatography.

673. Gas-Liquid Chromatography. I. Retention-Volume Data of Certain Tar Acids.

IRVINE, L. and MITCHELL, T. J.

J. Appl. Chem. (London) **8** (1) 3-6 (1958). *Chem. Abstr.* **52** 8508 (1958).

Corrected retention volumes for 30 tar acids are given. The experimental work was carried out on a 4 ft column of Apiezon L stopcock grease supported on Celite 535, using nitrogen as carrier gas with thermal conductivity detection.

674. Gas-Liquid Chromatography. II. Analysis of the Alkali Extract of a Low Temperature Coal Tar.

IRVINE, L. and MITCHELL, T. J.

J. Appl. Chem. (London) **8** (7) 425-432 (1958). *Chem. Abstr.* **52** 20997 (1958).

The analysis was carried out on a column of Apiezon L grease supported on Celite 535 at 183°C. Nitrogen was used as carrier gas.

675. Partition Chromatography.

IRVING, H. M. N. H. and WILLIAMS, R. J. P.

Sci. Progr. **41** 418-433 (1953). *Chem. Abstr.* **47** 8460 (1953).

Gives a general description of the subject—theory, factors controlling separation, paper chromatography and a very short summary on gas chromatography.

676. The Heats of Adsorption of *n*-Hexane and *n*-Heptane Vapours on Silica Gels.

ISIRIKYAN, A. A. and KISELEV, A. V.

Zhur. Fiz. Khim. **31** 2127-2137 (1957). *Chem. Abstr.* **52** 12539 (1958).

The heats of adsorption and adsorption isotherms were determined both on coarse- and fine-pored silica gels.

677. The Heat of Adsorption of Benzene and Hexane Vapours on Ignited and Hydrated Silica.

ISIRIKYAN, A. A. and KISELEV, A. V.

Doklady Akad. Nauk. S.S.S.R. **115** 343-346 (1957). *Chem. Abstr.* **52** 8714 (1958).

The heats of adsorption on variously hydrated silica surfaces were measured. An English translation of this article is available in *Proc. Acad. Sci. U.S.S.R., Sect. Phys. Chem.* **115** 473-476 (1957).

678. Heat of Adsorption of Benzene Vapours by Silica Gels.

ISIRIKYAN, A. A. and KISELEV, A. V.

Zhur. Fiz. Khim. **32** 679-688 (1958). *Chem. Abstr.* **52** 11515 (1958).

The heat of adsorption was determined on a coarse silica gel having a pore volume of 0.93 ml per gram.

- 679.** The Application of Gas-Liquid Chromatography to the Determination of Arcton 4 in Compressor Oil.

IVESON, G.

U.K. Atomic Energy Authority (Ind. Group) IGC-ARDC/P. 226.

The Arcton 4 was vaporised at a high temperature and passed through a column packed with compressor oil supported on C22 firebrick. Helium was used as carrier gas with thermal conductivity detection.

- 680.** Flavour Research on Cheese.

JACKSON, H. W.

Perfumery Essent. Oil Record **49** 256 (1958).

A solvent extract from a steam distillate gave 13 peaks from a Carbowax column, which were tentatively identified as:—methyl acetate, ethyl acetate, butyraldehyde, ethanol, diacetyl, ethyl butyrate, ?, ?, *n*-propanol and butanol (not separated) heptanone-2, ?, ?, and nonanone-2, in that order. A nose at the end of the column proved to be a sensitive detector, and detected and classified components not detected by the katharometer.

- 681.** Gas Chromatography for Automatic Process Stream Analysis.

JACKSON, R. G.

Proc. Instr. Soc. Am., Natl. Symposium Progr. Trends Chem. Petrol. Instrumentation, Wilmington **1** 61-68 (1958). *Chem. Abstr.* **52** 17822 (1958).

Because of its high selectivity and application to materials having widely differing volatilities, gas chromatography can be extremely useful in automatic stream analysis. The apparatus requirements are described.

- 682.** Gas Chromatography.

JACOBS, M. B.

Am. Perfumer Aromat. **67** 73-75 (1956).

A general article on the elementary principles of gas chromatography. Applications to flavour chemistry are briefly discussed.

- 683.** Composition of Onion Oil.

JACOBS, M. B.

Am. Perfumer Aromat. **70** (5) 53-56 (1957). *Chem. Abstr.* **52** 2344 (1958).

Apiezon M, Silicone SF 96-40, polystyrene glycol, and octyl phenoxypolyethylene glycol were investigated as stationary phases for aliphatic mercaptans, sulphides and disulphides. Only the last 2 would separate saturated from unsaturated sulphides and disulphides. Polyethylene glycol was used for analysis of onion oil, showing 16 components which included di-*n*-propyl disulphide, methyl-*n*-propyl disulphide and dimethyl disulphide.

- 684.** Separation of Volatile Materials by Gas-Liquid Chromatography.

JAMES, A. T.

Mfg. Chemist **26** (1) 5-10 (1955).

The development of the gas chromatographic method is discussed briefly, and detection methods using titration, thermal conductivity and the gas density balance are described.

- 685.** A New Technique for the Separation of Volatile Materials.

JAMES, A. T.

Research (London) **8** (1) 8-16 (1955). *Chem. Abstr.* **49** 8028 (1955).

A new technique which embodies the elements of gas-liquid chromatography is described. The mixture to be resolved into its volatile com-

ponents is passed through a column containing an inert solid, wetted by a non-volatile liquid, and an inert gas. The constituents of the mixture will be removed from the column in the gas stream at a rate depending on their volatility, and in this way a high degree of separation can be achieved.

686. Gas-Liquid Partition Chromatography: The Separation of Volatile Aliphatic Amines and of the Homologues of Pyridine.

JAMES, A. T.

Biochem. J. **52** 242-247 (1952). *Chem. Abstr.* **47** 446 (1953).

The separations were carried out on 4 ft columns of kieselguhr, impregnated with either liquid paraffin, Lubrol MO or Silicone DC 550. The stationary phases were compared, and it was found that liquid paraffin was superior to the others. It was found that the picolines (β - and p -), could not be separated by these stationary phases.

687. Gas-Liquid Chromatography.

JAMES, A. T.

Chem. Age (London) **73** 733-736 (1955).

A brief discussion of the applications of gas-liquid chromatography, and the factors influencing the separation of components. Detection methods using thermal conductivity and the gas density meter are described.

688. Separation of Volatile Materials by Gas-Liquid Chromatography.

JAMES, A. T.

Chem. Proc. Eng. **36** (3) 95-100 (1955).

Gas-liquid chromatography is a rapid, highly efficient and relatively simple means of separating volatile materials, and should be applicable to all substances capable of being distilled. Data are given for the separation of organic acids, ammonia and amines, aliphatic amines, petroleum ethers, aromatic hydrocarbons, methyl esters, alkyl chlorides and ketones.

689. A New Kind of Chromatogram.

JAMES, A. T.

Times Science Review. No. 16. Summer 1955. 8.

A description of gas chromatography, illustrated by the separation of volatile fatty acids and the methyl esters of aliphatic acids. The article describes 3 main methods of detection of components, and a flow detector.

690. Separation and Identification of Saturated and Unsaturated Fatty Acids from Formic to Dodecanoic Acid by Gas Chromatography.

JAMES, A. T.

Fette, Seifen, Anstrichmittel. **59** (2) 73-77 (1957). *Chem. Abstr.* **52** 6816 (1958).

In German. Methods for the separation of fatty acids are discussed, and examples of separations achieved are given. For the C_1 - C_8 acids the stationary phase was Silicone oil MS 550 containing 10% of stearic acid, the separation being carried out at 100°C.

691. Gas-Liquid Chromatography.

JAMES, A. T.

J. Pharm. and Pharmacol. **8** (4) 232-240 (1956). *Chem. Abstr.* **50** 13370 (1956).

A general article on the technique of gas chromatography, and an account of various detection methods including titration, thermal conductivity and the gas density meter. Factors affecting the separation of components are also discussed.

692. Gas-Liquid Chromatography. Separation and Microestimation of Volatile Aromatic Amines.

JAMES, A. T.

Anal. Chem. **28** (10) 1564-1567 (1956). *Chem. Abstr.* **51** 951 (1957).

The gas chromatographic behaviour of a variety of substituted amines has been studied. The information obtained can be applied to the analysis of aniline bases, and also to the elucidation of the effects of structural changes on retention volumes. The stationary phases used were either paraffin wax, liquid paraffin, Lubrol MO or benzyldiphenyl supported on Celite 545, at 137°C, and nitrogen was used as carrier gas.

693. Gas-Liquid Chromatography. A Method of Separation and Identification of Volatile Materials.

JAMES, A. T.

Can. Chem. Processing **40** 111-114 (1956).

A review.

694. The Gas-Liquid Chromatogram.

JAMES, A. T.

Endeavour **15** (58) 73-78 (1956). *Chem. Abstr.* **51** 42 (1957).

A general account of the technique and some applications, with 17 references.

695. Detection of Vapours in Flowing Gas Streams.

JAMES, A. T.

I.P. Symposium, London, 1956. 127-130.

Ed. DESTY, D. H. Published by Butterworths 1957.

Methods of vapour detection are reviewed including titration, thermal conductivity, gas density meter, volume measurement, flow impedance, hydrogen flame, and the vibrating reed electrometer.

696. Analysis in Medical Research.

JAMES, A. T.

Proc. Congr. Modern Anal. Chem. in Industry, June 1957. Published by Heffers 1958. 109.

A description of the application of gas chromatography to the separation of the methyl esters of fatty acids, and to the separation of the fatty acids of blood, rabbit sebum, etc.

697. Separation and Identification of Saturated and Unsaturated Fatty Acids from Formic to C₂₀ by Means of Gas-Liquid Chromatography.

JAMES, A. T.

Olui min. **34** (12) 539-543 (1957). *Anal. Abstr.* **5** 3168 (1958).

A general description illustrated by numerous examples. Some tables showing the retention volumes of the methyl esters on various stationary phases are included.

698. Liquid-Gas Partition Chromatography.

JAMES, A. T. and MARTIN, A. J. P.

Biochem. J. (Proc.) **48** vii (1951).

A very short general descriptive article.

699. Gas-Liquid Partition Chromatography—A Technique for the Analysis of Volatile Materials.

JAMES, A. T. and MARTIN, A. J. P.

Analyst **77** 915-932 (1952). *Chem. Abstr.* **47** 1529 (1953).

Describes the separation of volatile acids and bases, and an automatic recording burette for their detection and estimation. The separations were carried out on a 4 ft column of DC 550 silicone containing stearic acid.

- 700.** Gas-Liquid Partition Chromatography: The Separation and Microestimation of Volatile Fatty Acids from Formic to Dodecanoic Acid.
JAMES, A. T. and MARTIN, A. J. P.
Biochem. J. **50** 679-690 (1952). *Chem. Abstr.* **46** 4883 (1952).
Describes the theory of gas chromatography, and discusses factors affecting the degree of separation of components. A full description of the apparatus is given, including an automatic titration cell. A method is given for the estimation of volatile fatty acids isolated as their sodium salts.
- 701.** Gas-Liquid Partition Chromatography: The Separation and Microestimation of Volatile Fatty Acids and Bases.
JAMES, A. T. and MARTIN, A. J. P.
Congr. Intern. biochim. résumés communs, 2e Congr. Paris 1952. 159.
Chem. Abstr. **49** 12082 (1955).
The use of polar and non polar stationary liquids in the separation of amines is discussed.
- 702.** Gas-Liquid Chromatography: A Technique for the Analysis and Identification of Volatile Materials.
JAMES, A. T. and MARTIN, A. J. P.
Brit. Med. Bull. **10** (3) 170-176 (1954). *Chem. Abstr.* **49** 9428 (1955).
Separation methods are given for the materials enumerated below. In each case the inert support was kieselguhr and nitrogen was used as carrier gas. The appropriate stationary phase was as follows:—DC 550 silicone containing stearic acid for acids, hendecanol containing liquid paraffin for methylamines, Lubrol MO for aliphatic amines, liquid paraffin for aromatic bases and hydrocarbons, paraffin wax for ketones and benzyldiphenyl for aromatic hydrocarbons, alkyl chlorides, alcohols and esters. The arrangement of apparatus for use with both a titration detector and a gas density balance is shown schematically.
- 703.** Gas Chromatography.
JAMES, A. T. and MARTIN, A. J. P.
Mfg. Chemist **26** (5) 229 (1955).
A general descriptive article.
- 704.** Gas-Liquid Chromatography. A Technique for the Analysis and Identification of Volatile Materials.
JAMES, A. T. and MARTIN, A. J. P.
Chim. Anal. **37** (10) 321-326 (1955). *Anal. Abstr.* **3** 1048 (1956).
The technique for the separation of volatile fatty acids is described, and methods of detection discussed.
- 705.** Separation and Identification of Methyl Esters of Saturated and Unsaturated Fatty Acids from *n*-Pentanoic to *n*-Octadecanoic Acids.
JAMES, A. T. and MARTIN, A. J. P.
Biochem. Problems Lipids, Proc. Intern. Conf. 2nd Ghent 1955. 42-48 (pub. 1956). *Chem. Abstr.* **52** 11662 (1958).
See the previous reference.
- 706.** Gas-Liquid Chromatography: The Separation and Identification of the Methyl Esters of Saturated and Unsaturated Acids from Formic Acid to *n*-Octadecanoic Acid.
JAMES, A. T. and MARTIN, A. J. P.
Biochem. J. **63** (1) 144-152 (1956). *Chem. Abstr.* **50** 13660 (1956).
Micro amounts of the methyl esters of C_1 - C_8 saturated fatty acids are

separated at 78.7°C, and the esters of the saturated and unsaturated C₅-C₁₈ acids are separated at 197°C. Saturated and unsaturated acids may be distinguished by their chromatographic behaviour before and after chemical modification.

- 707.** The Separation and Identification of some Volatile Paraffinic, Naphthenic, Olefinic and Aromatic Hydrocarbons.

JAMES, A. T. and MARTIN, A. J. P.

J. Appl. Chem. (London) **6** (3) 105-115 (1956). *Chem. Abstr.* **50** 12455 (1956).

Gas chromatography is used in the separation of hydrocarbons, and stationary phases which can retard certain chemical structures are used to identify the different types of hydrocarbon. Some general considerations on the factors affecting separations are made.

- 708.** Gas-Liquid Partition Chromatography: The Separation and Micro-estimation of Ammonia and the Methylamines.

JAMES, A. T., MARTIN, A. J. P. and SMITH, G. H.

Biochem. J. **52** 238-241 (1952). *Chem. Abstr.* **47** 446 (1953).

Ammonia and the 3 methylamines can be separated on a column of hendecanol (5-ethylnonan-2-ol) containing liquid paraffin and supported on Celite 545 at 78.6°C. The Celite is acid washed, treated with methanolic sodium hydroxide, and dried at 100°C before use.

- 709.** The Metabolism of Propionic Acid.

JAMES, A. T., PEETERS, G. and LAURYSENS, M.

Biochem. J. **64** 726-730 (1956). *Chem. Abstr.* **51** 5223 (1957).

The steam volatile water soluble acids from milk were separated and identified by gas chromatography.

- 710.** Determination of the Structure of Unsaturated Fatty Acids on a Micro-scale with the Gas-Liquid Chromatogram.

JAMES, A. T. and WEBB, J.

Biochem. J. **66** 515-520 (1957). *Chem. Abstr.* **52** 248 (1958).

With the aid of the gas-liquid chromatogram, the methyl esters of mono- and dicarboxylic acids have been separated, and the structures of some naturally occurring mono- and di-unsaturated acids have been established: — e.g. the presence of vaccenic acids in human plasma, various mono-unsaturated octadecanoic acids in cows' milk. An unsaturated acid present in human red cells and plasma has also been isolated.

- 711.** Studies of Sebum. VI. The Determination of the Component Fatty Acids of Human Forearm Sebum by Gas-Liquid Chromatography.

JAMES, A. T. and WHEATLEY, V. R.

Biochem. J. **63** (2) 269-273 (1956). *Chem. Abstr.* **50** 14907 (1956).

The separated fatty acids were converted to their methyl esters and analysed by gas chromatography.

- 712.** A Simple Gas-Flow Control of High Efficiency.

JAMES, D. H. and PHILLIPS, C. S. G.

J. Sci. Instr. **29** 362-363 (1952). *Chem. Abstr.* **47** 3048 (1953).

A simple device is described which allows the delivery of a constant flow of gas with an accuracy of at least 0.2%. It consists of a choke upon which a constant pressure of gas is applied, and any excess gas is blown off through a sintered glass disc. Full details are given.

713. The Chromatography of Gases and Vapours. II.

JAMES, D. H. and PHILLIPS, C. S. G.

J. Chem. Soc. 1953. 1600-1610. *Chem. Abstr.* **47** 9861 (1953).

An apparatus is described for the analysis and separation of mixtures of volatile substances by the use of chromatographic methods in which the moving phase is a gas. Results are quoted to illustrate the absorption and partition techniques. Particular attention has been given to displacement (adsorption) analysis from charcoal columns at 100°C, where an accuracy of better than 1% can be obtained. A much fuller abstract is given in *Chem. Abstr.*

714. The Chromatography of Gases and Vapours. III. The Determination of Adsorption Isotherms.

JAMES, D. H. and PHILLIPS, C. S. G.

J. Chem. Soc. 1954. 1066-1070. *Chem. Abstr.* **48** 7958 (1954).

The paper shows how adsorption isotherms can be simply determined by the use of an apparatus designed for gas chromatography. To illustrate the method, the isotherms of benzene and cyclohexane have been determined on charcoal at 77° and at 100°C. A fuller abstract is given in *Chem. Abstr.*

715. Chromatographic Semi-microanalysis of Gases.

JANAK, J.

Chem. Listy. **47** 464-467 (1953). *Chem. Abstr.* **48** 3196 (1954).

Mixtures of hydrogen, air, helium, carbon monoxide, neon, argon and saturated and unsaturated hydrocarbons have been analysed by applying the principle of elution chromatography. The sample is mixed with carbon dioxide, passed through a column of activated charcoal or silica gel, eluted with carbon dioxide, and the separated fractions measured in an azotometer over potassium hydroxide. Examples, with chromatograms, of some analyses are given.

716. Chromatographic Semi-microanalysis of Gases. I. Theoretical and Practical Basis of Analysis.

JANAK, J.

Chem. Listy. **47** (6) 817-827 (1953). *Chem. Abstr.* **48** 3197 (1954).

See the previous reference. The theory of the method is discussed, and a full description of the apparatus is given.

717. Chromatographic Semi-microanalysis of Gases. II. Analysis of Natural Gas and Determination of Methane in Mine Gases.

JANAK, J.

Chem. Listy. **47** (6) 828-836 (1953). *Chem. Abstr.* **48** 3197 (1954).

The components of natural gas have been separated on a column of activated carbon and their characteristic elution volumes determined. The effect of temperature of the column on the reproducibility and accuracy of the method is discussed.

718. Chromatographic Semi-microanalysis of Gases. III. Analysis of Gases Rich in Hydrogen.

JANAK, J.

Chem. Listy. **47** (6) 837-841 (1953). *Chem. Abstr.* **48** 3197 (1954).

The gases were analysed by the method previously described on a column of activated carbon at 20°C.

- 719.** Chromatographic Semi-microanalysis of Gases. IV. Analysis of Gaseous Paraffins.
JANAK, J.
Chem. Listy. **47** 1184-1189 (1953). *Chem. Abstr.* **48** 3853 (1954).
The most suitable adsorbent for the analysis of paraffins was found to be silica gel, but activated carbon was best for the permanent gases. The paper includes a description of a universal apparatus, which incorporates both silica gel and activated carbon columns.
- 720.** Chromatographic Semi-microanalysis of Gases. VI. Analysis of Rare Gases.
JANAK, J.
Chem. Listy. **47** 1348-1353 (1953). *Chem. Abstr.* **48** 3854 (1954).
The analysis was carried out on a column of activated carbon at 20°C.
- 721.** Chromatographic Semi-microanalysis of Gases. Preliminary Communication.
JANAK, J.
Collection Czech. Chem. Commun. **18** (6) 798-802 (1953). *Chem. Abstr.* **48** 3196 (1954).
See reference 715.
- 722.** Chromatographic Semi-microanalysis of Gases. I-III.
JANAK, J.
Collection Czech. Chem. Commun. **19** (4) 684-699 (1954). *Chem. Abstr.* **49** 6777 (1955).
A summary of the articles given in references 716, 717 and 718.
- 723.** Chromatographic Semi-microanalysis of Gases. VI. Analysis of Inert Gases.
JANAK, J.
Collection Czech. Chem. Commun. **19** (5) 917-924 (1954). *Chem. Abstr.* **49** 6777 (1955).
See reference 720.
- 724.** Use of Zeolites in Gas Chromatography. Preliminary Communication.
JANAK, J.
Chem. Listy. **49** 1403-1405 (1955). *Chem. Abstr.* **50** 104 (1956).
The higher saturated and unsaturated hydrocarbons may be separated by gas chromatography using columns of zeolites, giving a sharp separation into narrow zones. The time required for an analysis is considerably less than that using silica gel. By suitably modifying the crystal lattice with metal ions, it is possible to separate normal from *iso*-hydrocarbons.
- 725.** Chromatographic Analysis and Separation of Gases.
JANAK, J.
Paliva **35** 357-361 (1955). *Chem. Abstr.* **50** 8173 (1956).
A general description of the theory and practical applications of gas chromatography. An automatic apparatus is shown.
- 726.** New Methods of Gas Analysis. Gas Chromatography.
JANAK, J.
Chem. Tech. (Berlin) **8** (3) 125-132 (1956). *Chem. Abstr.* **52** 155 (1958).
Essentially a review in which the theory and methods of gas chromatography are discussed. A full account is given of a systematic method of analysis. See previous references by the same author.

727. Systematic Chromatographic Micro-Analyses of Gases.

JANAK, J.

Mikrochim. Acta 1956 (4-6) 1038-1049. *Chem. Abstr.* **50** 10377 (1956).

Gives a review of the literature on gas chromatography up to 1955, and describes a method of analysis (see previous references). The idea of a gas chromatographic spectrum is formulated, and the relationship between the molecular structure of a compound and its position in such a spectrum is discussed.

728. Chromatographic Analysis of Connate Water in Oil Prospecting.

JANAK, J.

Prace Ustavu pro Naftovy Vyzkum Ser. E. No. 17/21 5-28 (1956). *Chem. Abstr.* **50** 16083 (1956).

The relationship between the quality of natural gas and petroleum deposits and the gases in solution in surface and connate water in the same locality have been investigated by a gas chromatographic method. Russian and German summaries of the article are given on pages 25-28.

729. Gas Chromatography on Various Adsorbents and with Liquid-Wetted Supports.

JANAK, J.

15th Int. Congr. of Pure and Appl. Chem., Lisbon, September 1956.

No further details are available.

730. The Concept of the Chromatographic Spectrum of Gases and Volatile Materials.

JANAK, J.

I.P. Symposium, London, 1956. 235-246.*Ed. DESTY, D. H. Published by Butterworths 1957.*

The chromatographic spectrum of gases and vapours is a graphic system of characteristic sorption data which permits a prediction of the separation of individual compounds and calculation of the optimal chromatograph columns, as well as a comparison of abilities of the different techniques. The relation of the structure of some gases and vapours to their position in the chromatographic spectrum is discussed.

731. Vapour-Phase Chromatography on Zeolites.

JANAK, J.

I.P. Symposium, London, 1956. 247-255.*Ed. DESTY, D. H. Published by Butterworths 1957.*

A description of adsorption chromatography using active Aluminium silicates is given. Carbon dioxide is used as carrier gas, but others may be used. New possibilities of the active Aluminium silicates are given.

732. New Trends in Gas Chromatography.

JANAK, J.

Chemie (Prague) **9** (1) 20-24 (1957). *Chem. Abstr.* **52** 7924 (1958).

A report of a lecture dealing with the selection of column packing materials, and of chemical and physical detectors for separated components.

733. New Methods in Gas Analysis. Gas Chromatography.

JANAK, J.

Erdol u Kohle **10** (7) 442-444 (1957). *Chem. Abstr.* **52** 155 (1958).

Essentially a review. See reference 726.

- 734.** Separation of Mono- and Di-Hydric Phenols by Means of Gas Chromatography.

JANAK, J. and KOMERS, R.

Presented at Meeting on 'The Analysis of Gaseous and Liquid Hydrocarbons and their Derivatives by Physical Methods'. Essen, January 1958. Printed in Z. anal. Chem. 164 (1) 69-72 (1958).

In German. Relative retention volumes of a number of phenols are given for several stationary phases together with the specific retention volumes of the standards.

- 735.** Evaluation of Some Sugars as Stationary Phases for Separation of Phenols by Gas Chromatography.

JANAK, J. and KOMERS, R.

Gas Chromatography 1958. Amsterdam Symposium—May 1958.

Ed. DESTY, D. H. Published by Butterworths 1958. 343-348. Discussion 348-350.

The influence of the hydrogen bonding between the phenolic hydroxyl groups and the functional groups $-SH$, $-NH_2$ and $-OH$ of the stationary phase on the separation of phenols and their homologues has been studied.

- 736.** Zeolites in Gas Chromatography. I. Separation and Analysis of Mixtures of Hydrogen, Methane, Nitrogen and Carbon Monoxide.

JANAK, J., KREJCI, M. and DUBSKY, H. E.

Chem. Listy. 52 (6) 1099-1107 (1957). Chem. Abstr. 52 15331 (1958).

The use of Linde Molecular Sieve Type A gave excellent results. Its properties were thoroughly investigated. Detection during chromatographic analysis was by thermal conductivity. See also reference 724.

- 737.** Some Problems in Gas Chromatography of a Gas-Adsorbent System.

JANAK, J. and KREJCI, M.

Presented at Symposium on Gas Chromatography. Leipzig, October 1958. Preprints 155-170.

In German. The influence of the quality of an adsorbent surface on the shape of an elution curve is discussed, together with considerations of the production of a homogenous surface.

- 738.** Chromatographic Semi-microanalysis of Gases. XIII. Separation of Chlorine, Bromine and Iodine.

JANAK, J., NEDOROST, M. and BUBENIKOVA, V.

Chem. Listy. 51 890-894 (1957). Chem. Abstr. 51 11924 (1957).

This method is especially useful for the determination of bromine in a large excess of chlorine. The gas is adsorbed on silica gel, and eluted with nitrogen or carbon dioxide. The separated fractions are determined polarographically by utilising the increase of the $Ti(IV)$ wave caused by the absorption of the halogens in a $Ti(III)$ solution.

- 739.** Chromatographic Semi-microanalysis of Gases. XIV. Direct Determination of Individual Gaseous Paraffins and Olefins in 1,3-Butadiene.

JANAK, J. and NOVAK, J.

Chem. Listy. 51 (10) 1832-1837 (1957). Chem. Abstr. 52 1860 (1958).

An absorption column is packed with silica impregnated with molten maleic anhydride, which absorbs the butadiene, and the chromatographic separation of the hydrocarbons is then carried out on a column of dimethyl-formamide supported on alusil.

740. Chromatographic Semi-microanalysis of Gases. VII. Analysis of Dissolved Gases.

JANAK, J. and PARALOVA, I.

Chem. Listy. **47** 1476-1480 (1953). *Chem. Abstr.* **48** 3854 (1954).

A stream of carbon dioxide is passed through the solvent to expel dissolved gases. The carbon dioxide is absorbed in potassium hydroxide solution, and the residual gas analysed chromatographically in the usual manner.

741. Chromatographic Semi-microanalysis of Gases. V. Analysis of Unsaturated C_2 and C_3 Hydrocarbons.

JANAK, J. and RUSEK, M.

Chem. Listy. **47** 1190-1196 (1953). *Chem. Abstr.* **48** 3853 (1954).

Mixtures of C_2 and C_3 hydrocarbons were separated on activated carbon at 20 and 80°C, and on silica gel at the same temperatures. The desorption rate could be increased if necessary by heating the column.

742. Chromatographic Semi-microanalysis of Gases. VIII. Separation and Analysis of some Halogenated Hydrocarbons.

JANAK, J. and RUSEK, M.

Chem. Listy. **48** (2) 207-211 (1954). *Chem. Abstr.* **48** 6321 (1954).

The hydrocarbons were separated on a column of silica gel at 20 to 85°C. The best results were obtained at 20°C.

743. The Chromatographic Semi-microanalysis of Gases. IX. Determination of Nitrous Oxide.

JANAK, J. and RUSEK, M.

Chem. Listy. **48** (3) 397-400 (1954). *Chem. Abstr.* **48** 7489 (1954).

Measurements of the characteristic elution volumes of nitrous oxide on activated carbon and silica gel at 20 and 80°C are reported. Nitrous oxide could be determined in the presence of nitrogen, hydrogen, methane and ethane, and the method is suitable for the analysis of the commercially supplied gas.

744. Chromatographic Semi-microanalysis of Gases. IV and V.

JANAK, J. and RUSEK, M.

Collection Czech. Chem. Commun. **19** (4) 700-711 (1954). *Chem. Abstr.* **49** 6777 (1955).

A summary of the articles reported in references 719 and 741.

745. Chromatographic Semi-microanalysis of Gases. XI. Direct Determination of Individual Olefins in Gases.

JANAK, J. and RUSEK, M.

Chem. Listy. **49** 191-199 (1955). *Chem. Abstr.* **49** 8047 (1955).

The olefins are absorbed and concentrated in a solution of 0.25 M mercuric perchlorate in 2 M perchloric acid, using a special apparatus. The characteristic elution volumes of some olefins on silica gel are given for temperatures of 20, 60 and 80°C.

746. Chromatographic Semi-microanalysis of Gases. IX. Determination of Nitrous Oxide.

JANAK, J. and RUSEK, M.

Collection Czech. Chem. Commun. **20** 343-347 (1955). *Chem. Abstr.* **49** 11498 (1955).

See reference 743.

- 747.** Chromatographic Semi-microanalysis of Gases. XI. Direct Estimation of Individual Olefins.
JANAK, J. and RUSEK, M.
Collection Czech. Chem. Commun. **20** (4) 923-932 (1955). *Chem. Abstr.* **50** 4715 (1956).
See reference 745.
- 748.** Chromatographic Semi-microanalysis of Gases. XII. Separation and Analysis of Gaseous Cycloparaffins.
JANAK, J., RUSEK, M. and LAZAREV, A.
Chem. Listy. **49** 700-705 (1955). *Chem. Abstr.* **49** 12201 (1955).
The analysis was extended to cyclopropane, methylcyclopropane, and cyclobutane, and their chromatographic spectra were measured on activated carbon at 80°C, and on silica gel at 20 and 80°C. Other applications of the method are discussed.
- 749.** Chromatographic Semi-microanalysis of Gases. XII. The Separation and Analysis of Gaseous Hydrocarbons.
JANAK, J., RUSEK, M. and LAZAREV, A.
Collection Czech. Chem. Commun. **20** (5) 1199-1205 (1955). *Chem. Abstr.* **50** 7672 (1956).
See the previous reference.
- 750.** Chromatographic Semi-microanalysis of Gases. X. Determination of Small to Minute Amounts of Helium, Neon and Hydrogen in Gases.
JANAK, J. and TESARIK, K.
Chem. Listy. **48** (7) 1051-1057 (1954). *Chem. Abstr.* **48** 13536 (1954).
The natural gas is concentrated by adsorption on carbon at the temperature of liquid air in a special apparatus. A sample is taken using a Toepler pump and analysed chromatographically.
- 751.** Chromatographic Semi-microanalysis of Gases. X. Determination of Minute and Trace Amounts of Helium, Neon and Hydrogen in Gases.
JANAK, J. and TESARIK, K.
Collection Czech. Chem. Commun. **20** 348-355 (1955). *Chem. Abstr.* **49** 11498 (1955).
See the previous reference.
- 752.** Chromatographic Semi-microanalysis of Gases. XV. Automisation of the Measuring Unit of a Gas Chromatograph.
JANAK, J. and TESARIK, K.
Chem. Listy. **51** (11) 2048-2054 (1957). *Chem. Abstr.* **52** 2652 (1958).
Using the direct measurement of the true volume of gaseous separated fractions at constant pressure (after the carbon dioxide carrier gas has been removed) as a basis, an automatic registering chromatograph was designed and constructed.
- 753.** The Automatisation of Gas Chromatographs using Volume Measurement.
JANAK, J. and TESARIK, K.
Presented at Meeting on 'The Analysis of Gaseous and Liquid Hydrocarbons and their Derivatives by Physical Methods', Essen, January 1958. Printed in Z. anal. Chem. **164** (1) 62-68 (1958).
In German. An automatic recording apparatus is described for use with the CO₂ absorption method. Collection of gas in the nitrometer displaces mercury and its movement is followed by means of a contact manometer, relays and compensating plungers moving in the mercury.

- 754.** Determination of 2,6-Di-*tert*-Butyl-4-Methyl 1-Hydroxybenzene on Anti-oxidant Treated Paperboard by Gas-Liquid Partition Chromatography.
JENNINGS, E. C., CURRAN, T. D. and EDWARDS, D. G.

Presented at 133rd National Meeting Am. Chem. Soc., San Francisco, April 1958. Abstracts p. 48B No. 129.

The paperboard is extracted with *cyclohexane/isopropyl alcohol*, the extract concentrated and then subjected to analysis by gas chromatography. See the next reference.

- 755.** Gas-Liquid Partition Chromatography. Determination of 2,6-Di-*tert* Butyl-*p*-Cresol on Antioxidant Treated Paperboard.

JENNINGS, E. C., CURRAN, T. D. and EDWARDS, D. G.

Anal. Chem. **30** (12) 1946-1948 (1958). *Chem. Abstr.* **53** 3691 (1959).

The *cyclohexane-isopropyl alcohol* extract from the paperboard is analysed by gas chromatography on a column of C22 firebrick impregnated with propylene glycol at 200°C, using helium as carrier gas with thermal conductivity detection.

- 756.** Application of Gas-Liquid Partition Chromatography to the Study of Volatile Flavour Compounds.

JENNINGS, W. G.

J. Dairy Sci. **40** (3) 271-279 (1957). *Chem. Abstr.* **51** 10789 (1957).

The ether extract of a starter distillate concentrate was analysed on a column of polyoxyethylene polypropylene glycol ether supported on Celite at 125-130°C, using helium as carrier gas with thermal conductivity detection.

- 757.** Ionisation by Alpha Particles in Mixtures of Gases.

JESSE, W. P. and SADAUSKIS, J.

Phys. Rev. **100** (6) 1755-1762 (1955). *Chem. Abstr.* **50** 4625 (1956).

The ionisation produced by α -particles is greatly increased by the presence of traces of impurities in helium. The effects of some of these are described. This paper provides a useful background to the development of ionisation detectors for use in gas chromatography.

- 758.** The Behaviour of the Solid Support in Gas-Liquid Partition Chromatography.

JOHNS, T.

Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.

Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 31-38. Discussion 38-39.

Details of a practical investigation carried out using 6 ft stainless steel columns (O.D. $\frac{1}{4}$ in.) at 130°C. The stationary phase was either Silicone 550 or Carbowax 600, and the solid supports were various types of diatomaceous earth (Celite 410, C22 Firebrick, Sterchamol 22 firebrick, chromosorb, Dicalite, Lompoc celite). The influence of particle size on the behaviour of these was determined.

- 759.** Determination of Blood Alcohol by Gas Chromatography.

JOHNS, T., ULRICH, W. F. and CADMAN, J.

Presented at Conf. on Anal. Chem., Pittsburgh, March 1958. Paper 115. No further details are available.

760. The Dimethyldiphenyls.

JOHNSON, E. A.

J. Chem. Soc. 1957 4155-4156. *Chem. Abstr.* **52** 4566 (1958).

A series of dimethyldiphenyls was prepared in order to study their u.v. spectra and gas-liquid chromatographic behaviour. The purities obtained were all greater than 99.5%. The physical properties were tabulated, and relative retention volumes given using a diphenyl standard, on a column of Apiezon M on alkali washed kieselguhr at 197°C. Nitrogen was used as carrier gas.

761. Liquid Substrates and the Gas-Liquid Partition Column.

JOHNSON, H. W.

Presented at 129th National A.C.S. Meeting, Dallas, Texas, April 1956. Abstracts p. 14B No. 36.

A theoretical discussion, illustrated by actual data, of parameters affecting the separation of the components of a mixture:—partition coefficients of sample between carrier gas and solvent, equilibrium between gas and liquid phases, pressure drop in column, sample size and method of injection, changes in activity coefficients with concentration, and time lag and linearity of the detector.

762. Determination of Column Efficiency in Gas-Liquid Chromatography.

JOHNSON, H. W. and STROSS, F. H.

Presented at Conf. on Anal. Chem., Pittsburgh, March 1958. Paper 143. No further details are available.

763. Terms and Units in Gas Chromatography.

JOHNSON, H. W. and STROSS, F. H.

Anal. Chem. **30** (10) 1586-1589 (1958). *A report sponsored by a Study Group of Section L on Gas Chromatography of Research Division IV, A.S.T.M. Committee D-2 on Petroleum Products and Lubricants.*

The definitions of terms and units given represent the widest interpretation of opinion practicable.

764. The Thermal Conductivities of Eight Common Gases between 80° and 380°K.

JOHNSTON, H. L. and GRILLY, E. R.

J. Chem. Phys. **14** (4) 233-238 (1946). *Chem. Abstr.* **40** 3951 (1946).

The thermal conductivities of oxygen, nitrogen, carbon monoxide, nitric oxide, hydrogen, helium, nitrous oxide, carbon dioxide and methane are given.

765. Purification of Argon.

JONES, R. A. and MILTON, R. M.

U.S. 2,810,454 (1957). *Chem. Abstr.* **52** 2474 (1958).

Describes the purification of argon by means of a molecular sieve zeolite.

766. The Analysis of C₆-C₉ Aromatics by Gas-Liquid Partition Chromatography.

JONES, W. C.

Advances in Gas Chromatography, A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D-117 to D-125. (Presented during 132nd Meeting, A.C.S.)

A method designed specifically for the separation of these compounds uses a 20 ft × ½ in. column packed with 40% Apiezon 'L' grease on C22 fire-brick at 297°F, with helium as carrier gas and thermal conductivity detection.

767. Physical Parameters in Gas Chromatography.

JONES, W. L.

Presented at Southwide Chem. Conf. on Instrumentation. Instr. Soc. Am. Symposium on Gas Chromatography, Memphis, Tennessee, December 1956.

No further details are available, but probably similar to reference 769.

768. Physical Parameters in Gas Chromatography.

JONES, W. L. and KIESELBACH, R.

Presented at Delaware Chem. Symposium, Univ. of Delaware, February 1957.

No further details are available, but probably similar in substance to the following reference.

769. Units of Measurement in Gas Chromatography.

JONES, W. L. and KIESELBACH, R.

Anal. Chem. **30** (10) 1590-1592 (1958).

New units to simplify recording and interpretation of experimental data are proposed. They will also characterise quantitatively the degree of resolution obtainable in analytical separations.

770. Modern Methods of Research.

JORDAN, L. A.

Chem. and Ind. (London) 1957 (11) 306.

A report of a lecture given by the author which includes a short general account of gas chromatography.

771. Gas-Liquid Partition Chromatography.

"J.R.M."

Chem. Prods. **19** (3) 122 (1956).

A brief general review of the subject.

772. Detectors for Vapour-Phase Chromatography.

"J.R.M."

Chem. Prods. **20** (5) 206-207 (1957). *Anal. Abstr.* **5** 1042 (1958).

A description of the katharometer, volume gas collector, titration cell, microflame-thermocouple and a simplified gas density balance.

773. Some New Methods in Chromatography.

"J.R.M."

Chem. Prods. **20** 338 (1957).

A review.

774. Bibliography on Gas Chromatography and Some Related Methods.

JUNEAU, J.

Petroleum Expt. Station, Bureau of Mines, Bartlesville, Oklahoma. Published by Consolidated Electrodynamics Corp. 1956.

A bibliography of 145 references on gas chromatography, with an appendix containing 24 references on the theory and construction of the thermal conductivity cell. An author index is also included.

775. Bibliography on Gas Chromatography and Some Related Methods. Supplement No. 1. Compiled and published by Consolidated Electrodynamics Corp. (1958).

A bibliography of 115 references to gas chromatography. An author index is included. (This reference is inserted here for convenience, as it follows logically from the previous one although not compiled by the same author.)

- 776.** Combined Colorimetric and Chromatographic Ultra-microanalysis of Gases. I. Analysis of Compounds forming Carbon Dioxide on Combustion. JURANEK, J.

Chem. Listy. **51** (12) 2280-2286 (1957). *Chem. Abstr.* **52** 4384 (1958).

The method of analysis used is based on a combination of gas chromatographic separation and the colorimetric determination of carbon dioxide. An apparatus for this purpose is described, and factors influencing the procedure are discussed.

- 777.** Modern Methods of Gas Analysis.

KAINZ, G.

Osterr. Chem.-Ztg. **59** (3-4) 45-51 (1958). *Anal. Abstr.* **5** 3596 (1958).

Some of the newer methods are reviewed, including such physical means of separation of the components of mixtures as adsorption and partition methods in gas chromatography.

- 778.** Detectors: A Highly Sensitive Thermal Conductivity Cell.

KAISER, R.

Presented at Symposium on Gas Chromatography, Leipzig, October 1958. Preprints 171-181.

In German. The sensitivities of various detectors and desirable and necessary properties are discussed. A thermal conductivity cell of high sensitivity is also described.

- 779.** Apparatus for the Delivery of Measured Amounts of Gases.

KALAB, V. and PINKAVA, J.

Chem. Listy. **52** (1) 156-158 (1958). *Chem. Abstr.* **52** 11481 (1958).

The delivery of gas is controlled by means of a magnetic valve activated by a relay, one contact of which is connected to a rubber membrane, and the other to a needle close to the membrane.

- 780.** Gas Sampling Apparatus.

KALLE, K. T.

G.P. 42L 4/01 1,003,974.

A device for the continuous withdrawal of gases for sampling purposes, consists of 2 elements in mutual contact and having coherent channels leading to the contacting surfaces, 1 element being rotatable and the other prevented from rotation.

- 781.** Gas-Liquid Partition Chromatography: The Separation and Micro-estimation of Volatile Fatty Acids from Formic Acid to Dodecanoic Acid.

KAMER, J. H. van de, GERRITSMA, K. W. and WANSINK, E. J.

Biochem. J. **61** (1) 174-176 (1955). *Chem. Abstr.* **49** 15641 (1955).

The apparatus used was that of James and Martin with slight modifications, enabling both lower and higher fatty acids to be separated and determined quantitatively on one column. Nitrogen was used as carrier gas, and detection was by titration.

- 782.** The Thermal Conductivity of Rare Gases.

KANNULUIK, W. G. and CARMAN, E. H.

Proc. Phys. Soc. (London) **65B** 701-709 (1952). *Chem. Abstr.* **46** 10736 (1952).

The thermal conductivities of neon, argon, helium, krypton and xenon were determined using a hot-wire method over the range -183 to 306°C .

783. The Thermal Conductivity of Some Gases at 0°.

KANNULUIK, W. G. and MARTIN, L. H.

Proc. Roy. Soc. (London) A **144** 496-513 (1934). *Chem. Abstr.* **28** 4656 (1934).

The thermal conductivities of air, hydrogen, carbon dioxide, oxygen, carbon monoxide, nitrous oxide, helium, neon and argon are reported.

784. Fractionation of Gas Mixtures in a Moving-Bed Adsorber.

KAPFER, W. H., MALOW, M., HAPPEL, J. and MARSEL, C. J.

A.I.Ch.E. Journal **2** 456-467 (1956). *Chem. Abstr.* **51** 2337 (1957)

A description is given of the design and operation of a pilot scale moving bed adsorber for the separation of $\text{CH}_4/\text{C}_2\text{H}_2$ and $\text{CH}_4/\text{CO}_2/\text{C}_2\text{H}_2$ on active charcoal. References are given to early work on 'hyperc sorption'.

785. Mass Spectrometry vs Vapour-Phase Chromatography.

KARASEK, F. W.

Chem. Eng. News **35** (18) 70 (1957).

A general comparison of the 2 methods of analysis.

786. Analysis of Low-Temperature Tar Phenols Boiling up to 234°.

KARR, C., BROWN, P. M., ESTEP, P. A. and HUMPHREY, G. L.

Fuel **37** 227-235 (1958). *Chem. Abstr.* **52** 9566 (1958).

The separation was carried out by gas-liquid partition chromatography, and the separated fractions determined by infra-red analysis. A comparison of the results was made with those obtained by the conventional method of fractional distillation.

787. Identification and Determination of Low Boiling Phenols in Low Temperature Coal Tar.

KARR, C., BROWN, P. M., ESTEP, P. A. and HUMPHREY, G. L.

Presented at 132nd Meeting, A.C.S. New York, September 1957. *Abstracts p. 5K No. 14.*

The phenols were determined by gas-liquid partition chromatography, and also by fractional distillation followed by infra-red analysis. The 2 methods were compared. See the following reference.

788. Identification and Determination of Low Boiling Phenols in Low Temperature Coal Tar.

KARR, C., BROWN, P. M., ESTEP, P. A. and HUMPHREY, G. L.

Anal. Chem. **30** (8) 1413-1416 (1958). *Chem. Abstr.* **52** 20997 (1958).

The gas-liquid partition chromatographic column used was packed with C22 firebrick impregnated with di-*n*-octyl phthalate at 160°C. The sample size was 250 μl , and helium was used as carrier gas. The separated components were identified by their relative retention times, and determined using their peak areas.

789. Butadiene-Vinyl Acetylene Analysis by Gas Chromatography.

KAUFMAN, H. R. and ZLATKIS, A.

Chem. and Ind. (London) 1958 (32) 1001. *Chem. Abstr.* **53** 5980 (1959).

The 30 ft column employed was packed with 5% isosafrole on C22 firebrick and was operated at 25°C, using helium as carrier gas. The chromatogram of a typical sample is given, showing that isobutane, butane, 1-butene and *trans*-2-butene are present.

790. Application of Gas-Phase Chromatography to Boron Hydrides.

KAUFMAN, J. J., TODD, J. E. and KOSKI, W. S.

Anal. Chem. **29** (7) 1032-1035 (1957). *Chem. Abstr.* **51** 13651 (1957).

The pure compounds, diborane, tetraborane and pentaborane were prepared by chromatographic separation on a 10 ft $\times$ $\frac{1}{4}$ in. column packed with Celite 545 impregnated with either paraffin oil, Octoil S or tritolyl phosphate. Helium was used as carrier gas, with detection by a thermal conductivity cell using thermistors.

791. Air Pollution.

KAY, K.

Anal. Chem. **29** (4) 589-604 (1957). *Chem. Abstr.* **51** 7218 (1957).

No details are given in *Chem. Abstr.* The article contains sections which refer to gas chromatography as an analytical method, with particular reference to hydrocarbons (p. 597) and measurement methods (p. 598).

792. An Apparatus for Analysis by the Gas Chromatographic Method.

KEARNS, R. and GUILD, L. V.

Presented at Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, February 1956.

An apparatus manufactured by the Burrell Corporation was described. Columns of 5 mm I.D. and up to 25 ft in length can be used. The temperature of the column is controlled up to 250°C while that of the thermal conductivity cell is separately controlled up to 200°C. A unit with 2 columns, and 2 detectors, but only 1 recorder is available.

793. The Decomposition of 1-Butene and 1-Butene-4,4,4-d₃ Induced by Methyl Radicals.

KEBARLE, P. and BRYCE, W. A.

Can. J. Chem. **35** 576-579 (1957). *Chem. Abstr.* **51** 16273 (1957).

The products of reaction were separated and identified using gas chromatography and mass spectrometry. A fuller abstract is given in *Chem. Abstr.*

794. Chromatography.

KELLER, R. A.

Univ. Microfilms. Publ. 20043. 110 pp. *Dissert. Abstr.* **17** 757 (1957). *Chem. Abstr.* **51** 11810 (1957).

Gives a comparison of vapour-phase and liquid-liquid partition chromatography with reference to thermodynamic properties.

795. Separation of Acetylene by the Continuous Adsorption Method.

KEL'TSEV, N. V. and KHALIF, A. L.

Khim. i Tekhnol. Topliva 1956 (12) 17-22. *Chem. Abstr.* **51** 5387 (1957).

Complete separation of acetylene is possible on either a stationary or a moving bed of activated charcoal. Silica gel and bauxite were also investigated as possible adsorbents. The application of such a method on an industrial scale is discussed.

796. Application of Vapour-Phase Chromatography.

KEPPLER, J. G.

Chem. Weekbl. **51** (51) 911-914 (1955). *Anal. Abstr.* **3** 1928 (1956).

Detection methods are particularly discussed. The use of a platinum wire katharometer is most suitable for the detection of fatty acid esters and fatty alcohols. C₈-C₁₄ alcohols are separated best at 160°C, but C₁₆ and C₁₈ alcohols require a temperature of 185°C.

797. Vapour-Phase Chromatography at High Temperatures.

KEPPLER, J. G., DIJKSTRA, G. and SCHOLS, J. A.

*I.P. Symposium, London, 1956. 222-234.**Ed. DESTY, D. H. Published by Butterworths 1957.*

An apparatus for use up to 300°C is described. It is used to facilitate the separation of microgram samples and the collection of the separated fractions. A metal thermal conductivity cell was used for temperatures up to 250°C, and a glass cell for temperatures up to 300°C. The sensitivity of the cell is discussed in relation to the influence of both cell current and cell temperature.

798. Gas-Liquid Partition Chromatography.

KEPPLER, J. G., SCHOLS, J. A. and DIJKSTRA, G.

Olii grassi e saponi, April 1956.

Aliphatic acids, esters and alcohols from C₄-C₁₈ are separated on a silicone column, and aldehydes on paraffin wax. Quantitative analysis is possible.

799. A Multiple Gas Chromatographic Apparatus for Use at Temperatures up to 250°C.

KEPPLER, J. G., SCHOLS, J. A. and DIJKSTRA, G.

Rec. trav. chim. **75** (7) 965-976 (1956). *Chem. Abstr.* **50** 15135 (1956).

In English. A description is given of an apparatus for the separation of high boiling mixtures by means of vapour-phase chromatography at temperatures up to 250°C. The stationary phase consists of either silicone grease or silicone rubber on Celite 545, and the detector is a katharometer working at the same temperature.

800. Chromatographic Techniques.

KESZLER, I.

Chemia. (Buenos Aires) **17** 36-42 (1957). *Chem. Abstr.* **52** 1837 (1958).

A review giving 29 references.

801. Discussion on Katharometers as Recorders in Gas Chromatography.

KEULEMANS, A. I. M.

Analyst. **81** 57-58 (1956).

A short discussion with contributions by A. F. Williams and D. Harvey, which took place during the Symposium on Gas Chromatography held at Stevenston, Scotland, May 1955.

802. Gas Chromatography.

KEULEMANS, A. I. M.

Ed. VERVER, C. G. Published by Reinhold Pub. Corp., New York, 1957. pp. 216.

A book giving a comprehensive review of the whole subject, including both theory and practice, and gas-solid as well as gas-liquid chromatography. Some special applications of gas-liquid chromatography are given in Chapter 7, and the principal types of stationary phases are described in Appendix I. Appendix II gives a full description of katharometers.

803. Some Theoretical Aspects of Gas-Liquid Chromatography.

KEULEMANS, A. I. M.

Advances in Gas Chromatography—A.C.S. Symposium, New York, September 1957. Published by A.C.S. 1957. D-5 to D-14. (Presented during 132nd Meeting, A.C.S.)

Gives a short description of the procedure of gas-liquid chromatography, and discusses both ideal and linear chromatography. Both the selective retardation of solutes on the column, and factors affecting column efficiency are discussed, and the plate concept is compared with its analogous concept in distillation.

- 804.** Apparatus for the Analysis of Mixtures of Gases by Means of Gas-Adsorption Percolation.
KEULEMANS, A. I. M. and KWANTES, A.
B.P. 784,169 (1957). *Chem. Abstr.* **52** 4258 (1958).
The apparatus is arranged so that the gas adsorption column and detector are housed in a single temperature-controlled chamber.
- 805.** The Selectivity of the Stationary Liquid in Vapour-Phase Chromatography.
KEULEMANS, A. I. M., KWANTES, A. and ZAAL, P.
Anal. Chim. Acta **13** (4) 357-372 (1955). *Chem. Abstr.* **50** 3943 (1956).
Vapour-phase chromatography is a highly efficient analytical technique for the separation of gases and volatile liquids. The stationary phase in this process is a liquid supported by an inert solid carrier of a suitable particle size. The important role played by this liquid in the separation of a mixture into its components is discussed.
- 806.** Analysis of Volatile Organic Compounds by Means of Vapour-Phase Chromatography.
KEULEMANS, A. I. M. and KWANTES, A.
Presented at 4th World Petroleum Congress, Rome 1955. Abstract in Petroleum Times **59** 458 (1955) and *Fuel Abstr.* **18** 3707 (1955).
This paper gives an outline of the techniques of vapour-phase chromatography that have been developed. The flexibility of the method is illustrated by means of some practical examples taken from widely different regions of the petroleum field.
- 807.** Factors Determining Column Efficiency in Gas-Liquid Partition Chromatography.
KEULEMANS, A. I. M. and KWANTES, A.
I.P. Symposium, London, 1956. 15-34.
Ed. DESTY, D. H. Published by Butterworths 1957.
An equation developed by van Deemter, Zuiderweg and Klinkenberg for the efficiency of the column in 'linear non-ideal' chromatography is considered, and the influence on the efficiency caused by varying the parameters of this equation are discussed with reference to gas chromatography.
- 808.** Quantitative Analysis with Thermal Conductivity Detection in Gas-Partition Chromatography.
KEULEMANS, A. I. M., KWANTES, A. and RIJNDERS, G. W. A.
Presented at 15th Int. Congr. Pure and Appl. Chem. Lisbon, September 1956.
No further details are available, but see the next reference.
- 809.** Quantitative Analysis with Thermal Conductivity Detection in Gas-Liquid Chromatography.
KEULEMANS, A. I. M., KWANTES, A. and RIJNDERS, G. W. A.
Anal. Chim. Acta **16** (1) 29-39 (1957). *Chem. Abstr.* **51** 7931 (1957).
In English. The form of detector now most generally used in gas chromatography is the katharometer. This detector, in common with certain other differential types that have been employed, requires calibration for a quantitative interpretation of the elution curve, since the signal recorded is not dependent on some simple molecular parameter of the eluted component and also is not a linear function of its concentration. The present paper mentions several causes of this non-linearity, and gives examples of hydrocarbon analysis.

810. The Principles and some Applications of Gas Chromatography.

KEULEMANS, A. I. M. and RIJNDERS, G. W. A.

Naturwissenschaften **45** 301-309 (1958). *Chem. Abstr.* **52** 16005 (1958).

A review with 20 references.

811. Reactivities of Naphthenes over a Platinum Reforming Catalyst by a Gas Chromatographic Technique.

KEULEMANS, A. I. M. and VOGEL, H. H.

Presented at 133rd Natl. Meeting, Am. Chem. Soc. San Francisco, April 1958. Abstract p. 14I No. 36.

A microreactor coupled directly to a gas chromatography apparatus was used to determine the reactivities of 30 individual C_6 - C_8 naphthenes using very small samples. The catalyst used was a Pt-alumina-halogen type, stabilised by use with a sulphur containing feed. Tests were carried out at 200-400°C, using excess hydrogen.

812. Thermal Conductivity of Gases.

KEYES, F. G.

Trans. Am. Soc. Mech. Engrs. **76** 809-816 (1954). *Chem. Abstr.* **48** 10398 (1954).

Measurements were made of the density and pressure coefficients of neon, argon, hydrogen, nitrous oxide, methane, ammonia and some Freons, and their viscosities obtained by correlating the relevant data available in the literature. The transport properties of gases are discussed.

813. Reversible and Irreversible Adsorption of Vapours by Solid Oxides and Hydrated Oxides.

KIPLING, J. J. and PEAKALL, D. B.

J. Chem. Soc. 1957 834-842. *Chem. Abstr.* **51** 7099 (1957).

The method of distinguishing between physical and chemical adsorption on oxides and hydrated oxides at room temperature is described. Physical adsorption of simple organic vapours takes place on some adsorbents, but on alumina, silica gel and titania gel, water vapour and lower aliphatic alcohols are held by chemisorption. Physical adsorption can take place on the chemisorbed layer.

814. An Apparatus for Laboratory Preparative-Scale Vapour-Phase Chromatography.

KIRKLAND, J. J.

*Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.**Ed. COATES, V. J., NOBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 203-222.*

Describes an apparatus for separating high purity gases, liquids and low melting solids in amounts up to about 10 g using thermal conductivity detection. The applications given include the purification of *n*-butanol, dimethylamine, and *p*-methoxyacetophenone.

815. Effect of the Size of Pores and of the Chemical Nature of the Surface of Silica Gels on their Adsorption Properties.

KISELEV, A. V.

Trudy Komissii Anal. Khim. Akad. Nauk. S.S.S.R., Inst. Geokhim. i Anal. Khim. **6** 46-76 (1955). *Chem. Abstr.* **50** 7540 (1956).

A review giving 52 references. No other details are given in *Chem. Abstr.*

816. Reactions of Methylene. II. Ketene and Carbon Dioxide.

KISTIAKOWSKY, G. B. and SAUER, K.

J. Am. Chem. Soc. **80** (5) 1066-1071 (1958). *Chem. Abstr.* **52** 11591 (1958).

Describes the extensive use of gas chromatography for the analysis of complex mixtures of reaction products. The columns used were 6 ft × 6 mm, thermostatted and packed with activated alumina. They were operated at 90-125°C, using helium as carrier gas and thermal conductivity detection.

817. Iso-Thiocyanates. XXIX. Separation of Volatile Iso-Thiocyanates by Gas Chromatography.

KJAER, A. and JART, A.

Acta Chem. Scand. **11** 1423 (1957). *Chem. Abstr.* **52** 9959 (1958).

The separation was carried out on a 2 m column packed with Dixon rings coated with silicone grease, using nitrogen as carrier gas. The mixture contained methyl-, ethyl-, isopropyl-, *n*-butyl- and isoamyl thiocyanates.

818. Correlation between Chromatographic Adsorbability on Alumina and Polarographic Reducibility of Conjugated Hydrocarbons.

KLEMM, L. H. and REED, D.

Presented at 133rd Meeting A.C.S. San Francisco, April 1958. Abstract p. 6P No. 17.

General agreement was found between the theoretically derived direct relationship of the relative chromatographic adsorbability and the algebraic value of the polarographic half-wave reduction potential of conjugated hydrocarbons.

819. Methods of Gas Analysis.

KLIMA, J.

Paliva **32** 275-282 (1952). *Chem. Abstr.* **50** 8391 (1956).

Methods for the analysis of gaseous hydrocarbons are given, and include adsorption and desorption methods. 45 references are included.

820. Holding-Time Distributions of the Gaussian Type.

KLINKENBERG, A. and SJENITZER, F.

Chem. Eng. Sci. **5** (6) 258-270 (1956). *Chem. Abstr.* **51** 778 (1957).

A discussion including a consideration of chromatography in relation to holding-time distributions.

821. Gas Chromatography of Olefins. Determination of Pentenes and Hexenes in Gasoline.

KNIGHT, H. S.

Anal. Chem. **30** (1) 9-15 (1958). *Chem. Abstr.* **52** 8521 (1958).

Techniques have been developed for the analysis of C₅ and C₆ olefins. These olefins together may be separated on columns of 1.5% squalane on Pelletex. The pentenes themselves are separated on 20% dimethylsulpholane on C22 firebrick, and any pairs requiring a further separation can be resolved on di-isodecyl phthalate on C22 firebrick. The hexenes are separated on 40% oxydipropionitrile on firebrick.

822. Gas-Liquid Chromatography of Hydroxyl and Amino Compounds. Production of Symmetrical Peaks.

KNIGHT, H. S.

Anal. Chem. **30** (12) 2030-2032 (1958).

A discussion on dissymmetry in peaks with experimental illustrations. Peak symmetry of polar materials may be definitely improved by adding a similar

polar material continuously with the carrier gas and operating the column at the proper temperature.

823. Application of Gas-Phase Partition Chromatography to Competitive Chlorination Reactions.

KNOX, J. H.

Chem. and Ind. (London) 1955 (50) 1631-1632. *Chem. Abstr.* **50** 13713 (1956).

It is considered that the preliminary results reported demonstrate that the gas chromatographic technique is a powerful and accurate tool for the quantitative analysis of small quantities of reaction products such as are obtained in kinetic experiments and have provided values for relative activation energies of chlorination of CH_4 , C_2H_6 , and C_3H_8 which are very much more accurate than those previously reported. The alkyl chlorides were separated on a column of Celite/silicone oil, using nitrogen as carrier gas and thermal conductivity detection.

824. Gas Chromatography.

KNOX, J. H.

Sci. Progr. **45** 227-244 (1957). *Chem. Abstr.* **51** 9398 (1957).

A review giving 25 references.

825. Synthesis of Activated Molecules: Methyl Cyclopropane.

KNOX, J. H. and TROTMAN-DICKENSON, A. F.

Chem. and Ind. (London) 1957 (30) 1039. *Chem. Abstr.* **52** 1076 (1958).

The reaction products were analysed by gas chromatography on a column of nitrobenzene supported on firebrick.

826. Competitive Oxidations. I. Ethane + Propane Mixtures.

KNOX, J. H., SMITH, R. F. and TROTMAN-DICKENSON, A. F.

Trans. Faraday Soc. **54** (10) 1509-1514 (1958).

The analysis were carried out entirely by gas chromatography using the Janak technique. A column (250 cm $\times$ 6 mm) was packed with activated alumina, and run at 20°C with carbon dioxide as carrier gas.

827. Reactions of Methylene with Isobutene.

KNOX, J. H., TROTMAN-DICKENSON, A. F. and WELLS, C. H. J.

J. Chem. Soc. 1958 2897.

The products of the reactions were analysed by gas chromatography and infra-red spectroscopy.

828. Separation and Purification of Organic Compounds by Means of Sublimation Through Adsorptive Substances.

KOFLER, W.

Monatsh. **80** 694-701 (1949). *Chem. Abstr.* **44** 3407 (1950).

Compounds or impure mixtures are sublimed under reduced pressure, and transported by means of a carrier gas through a column of adsorbent, when a chromatographic separation takes place.

829. Thermo-Gas-Chromatography, a New Method for the Separation and Determination of Mixtures.

KOGLER, H.

Chem. Tech. (Berlin) **9** (7) 400-403 (1957). *Chem. Abstr.* **52** 154 (1958).

A description of an apparatus and method in which the temperature is raised at a definite rate. The column may consist of alumina, silica gel,

or a high boiling liquid on an inert support. The carrier gas may be hydrogen, nitrogen or carbon dioxide, and detection is by thermal conductivity. The method is suitable for the separation of hydrocarbon mixtures.

830. Examination of Mineral Oil Products by Gas Chromatography.

KOGLER, H.

Presented at Symposium on Gas Chromatography, Leipzig, October 1958. Preprints 182-189.

In German. The separation of hydrocarbon fractions up to *n*-nonane and xylenes is discussed.

831. Automatic Gas Analysis in Industrial Control.

KOGLER, H., HULTSCHIG, M., FISCHER, J. and WEIDENBACH, G. *Chem. Tech. (Berlin)* **9** (4) 220 (1957). *Chem. Abstr.* **51** 13359 (1957).

Gives a description of a fully automatic gas-phase chromatograph for the analysis of a butane distillation stream.

832. New Microcatalytic-Chromatographic Technique for Studying Catalytic Reactions.

KOKES, R. J., TOBIN, H. and EMMETT, P. H.

J. Am. Chem. Soc. **77** (22) 5860-5862 (1955). *Chem. Abstr.* **50** 5382 (1956).

Describes the use of adsorption or partition chromatography in the study of the products of catalytic reactions. The separated components are identified by means of a Geiger counter in series with a thermal conductivity or other detector.

833. Gas-Liquid Partition Chromatography of Stereoisomeric Methylcyclohexanols.

KOMERS, R., KOCHLOEFL, K. and BAZANT, V.

Chem. and Ind. (London) 1958 (43) 1405-1406.

The separation was carried out on a column of either glycerol (17%) or erythritol (25%) supported on Celite 545, and using nitrogen as carrier gas with thermal conductivity detection.

834. Gas Chromatographic Characterisation of Organic Compounds. I. Retention Indices for Aliphatic Halides, Alcohols, Aldehydes and Ketones.

KOVATS, E.

Helv. Chim. Acta **41** 1915-1932 (1958). *Chem. Abstr.* **53** 8765 (1959).

In German. A value called the retention index is proposed for the characterisation of organic substances. A simple relation exists between the retention index of a compound on a non-polar stationary phase and its boiling point. To achieve a defined separation of 2 components on a given column, a minimum difference in their retention indices is required. An equation is given relating this difference to the temperature of the column.

835. Standard Substance Technique for the Gas Chromatographic Characterisation of Organic Compounds.

KOVATS, E. and HEILBRONNER, E.

Chimia. (Switz.) **10** 288-289 (1956). *Chem. Abstr.* **51** 5638 (1957).

An expression is derived showing the relationship between pressure $\times$ volume, temperature and retention volume considered in conjunction with the use of internal standards.

- 836.** Programme-Controlled Gas Chromatography for Preparative Separation of Organic Compounds. II.
KOVATS, E., SIMON, W. and HEILBRONNER, E.
Helv. Chim. Acta **41** 275-288 (1958). *Chem. Abstr.* **52** 8826 (1958).
Describes the study of variable parameters in a previously reported apparatus. The variables investigated were temperature, retention volume, flow rate of carrier gas, amount of sample, and stationary phase (apolar Celite/Apiezon L and polar Celite/Emulphor O).
- 837.** Analysis of Lacquer Solvents by Gas-Distribution Chromatography. I. Qualitative Analyses.
KRATZL, K. and GRUBER, K.
Holzforsch. u. Holzverwert. **9** 87-90 (1957). *Chem. Abstr.* **52** 7734 (1958).
Describes a method for the qualitative determination of the components of lacquer solvents.
- 838.** Some Gas-Phase Reactions of Butyl Free Radicals.
KRAUS, J. W. and CALVERT, J. G.
Presented at 131st Nat. Meeting A.C.S. Miami, Florida, April 1957. Abstracts p. 43R No. 105.
The products of reaction were analysed by vapour-liquid partition chromatography and mass spectrometry. No further details are given in the abstract.
- 839.** Chromatographic Method of Separate Determination of Butadiene, Ethylbenzene and Styrene in Air.
KRIVORUCHKO, F. D. and TURKELTAUB, N. M.
Zavodskaya Lab. **22** (12) 1408-1409 (1956). *Chem. Abstr.* **51** 4879 (1957).
The total carbon content of the sample (as carbon dioxide) is determined by passing through a combustion train. A similar sample is adsorbed on silica gel, and then displaced by the passage of warm air. Desorption temperatures are 70-85°, 170° and 300°C for butadiene, ethylbenzene and styrene respectively.
- 840.** Selective Adsorption of Hydrocarbon and Water Vapour on Alumina at Atmospheric Pressure.
KU, C. C., HUNTINGTON, R. L. and REID, L. S.
Am. Inst. Mining Met. Engrs. Tech. Pub. No. 1628 (1943). *Chem. Abstr.* **38** 1345 (1944).
A study was carried out of the adsorption by alumina of water and hydrocarbon vapour from natural gas. Water vapour in the hydrocarbon gas inhibits the adsorption of hydrocarbon, but, on the other hand, the adsorption of water vapour is not affected by the presence of hydrocarbon.
- 841.** Microchemical Analysis of Low-Boiling Hydrocarbons by Means of Fractional Desorption.
KUCHLER, L. and WELLER, O. G.
Mikrochemie **26** 44-53 (1939). *Chem. Abstr.* **33** 3294 (1939).
The analysis is carried out at low temperatures on norite. A complete identification also includes a microcombustion determination.
- 842.** Perspectives in Quantitative Organic Microanalysis.
KUCK, J. A.
Anal. Chem. **30** (9) 1552-1556 (1958). *Chem. Abstr.* **52** 19711 (1958).
A description of gas chromatography is included in this article.

- 843.** Construction and Adjustment of an Electronically Stabilised Network for the Supply of Current to the Thermal Conductivity Cell in Gas Chromatography.

KUHL, M.

Presented at Symposium on Gas Chromatography, Leipzig, October 1958. Preprints 190-195.

In German. The need for a stabilised voltage supply for heating thermal conductivity cells is discussed and an electronic system described for 8 V with current up to 400 mA with a stability of $\pm 0.1\%$ when the supply varies $\pm 15\%$.

- 844.** Continuous Gas Chromatography. I. Process for the Continuous Separation of a Multicomponent Mixture in a Two Phase Counter Current System with Temperature Gradient.

KHUN, W., NARTEN, A. and THURKAUF, M.

Helv. Chim. Acta **41** 2135-2148 (1958). *Chem. Abstr.* **53** 8765 (1959).

The continuous separation of a multicomponent mixture in a single stage is described. Basically it depends on a system of 2 non-miscible phases flowing counter-current to one another. A temperature gradient is maintained along the axis of the system. Very similar substances may be separated.

- 845.** Analysis of Hydrocarbon Mixtures.

KUHNHANSS, G., ROSNER, H., HUTTIG, E., WAGNER, M. and TISCHENDORF, G.

Erdol. u. Kohle **10** 372-375 (1957). *Chem. Abstr.* **51** 16205 (1957).

A method is described which combines urea adduction, extraction, vacuum distillation, chromatography, thermodiffusion and fractional crystallisation.

- 846.** Automatic Gas Flow Rate Regulator.

KULCSAR, G. J. and KULCSAR-NOVAKOVA, M.

Acad. rep. populare Romine, Filiala Cliej, Studii cercetari chim. **7** (1-4) 119-132 (1956). *Chem. Abstr.* **52** 8632 (1958).

The regulator is described and its performance given.

- 847.** The Determination of Activity Coefficients at Infinite Dilution by Gas-Liquid Chromatography.

KWANTES, A. and RIJNDERS, G. W. A.

Gas Chromatography 1958. *Amsterdam Symposium—May 1958.*

Ed. DESTY, D. H. Published by Butterworths 1958. 125-135. *Discussion* 135-136.

It has been found that some difficulties can be overcome by using a support of non-polar character e.g. fine metal helices, and that an extension of the method to solvents of higher volatility was possible by presaturating the carrier gas with vapours of the solvent.

- 848.** Cool-Flame Combustion Studies of Hydrocarbons by Gas Chromatography.

KYRYACOS, G.

Univ. Microfilms. Publ. 21442. *Dissert. Abstr.* **17** 1216 (1957). *Chem. Abstr.* **51** 14235 (1957).

No details given in *Chem. Abstr.*, but see the next reference.

- 849.** Gas-Adsorption Chromatography in the Analysis of Cool Flame Combustion Products.
KYRYACOS, G. and BOORD, C. E.
Presented at 131st National A.C.S. Meeting, Miami, Florida, April 1957. Abstracts p. 35B No. 91.
 C_3 - C_5 paraffin and olefin hydrocarbons are determined on a column of 45% Dowtherm-A on C22 firebrick; CO_2 , C_2H_4 and C_2H_2 on a column of silica gel at 80°C, and H_2 , O_2 , N_2 , CH_4 and CO on a column of molecular sieve 5A at 100°C.
- 850.** Separation of Hydrogen, Oxygen, Nitrogen, Methane and Carbon Monoxide by Gas-Adsorption Chromatography.
KYRYACOS, G. and BOORD, C. E.
Anal. Chem. **29** (5) 787-788 (1957). *Chem. Abstr.* **51** 10177 (1957).
A 16 ft column of molecular sieve Type 5A was used at 100°C using helium as carrier gas with thermal conductivity detection.
- 851.** Stresses and Strains in Adsorbate-Adsorbent Systems. IV. Contractions of Activated Carbon on Adsorption of Gases and Vapours at Low Initial Pressures.
LAKHANPAL, M. L. and FLOOD, E. A.
Can. J. Chem. **35** 887-899 (1957). *Chem. Abstr.* **52** 19337 (1958).
An activated carbon rod was used, and variations in its length measured after adsorption of ethane, propane, butane, pentane, carbon tetrachloride or methanol.
- 852.** High Energy Electron Irradiation of Neopentane.
LAMPE, F. W.
Presented at 131st National A.C.S. Meeting, Miami, Florida, April 1957.
Gas chromatography was used to separate the products of reaction.
- 853.** Heat Bridge for Measuring Thermal Conductivity.
LANDEGREN, G. F.
Am. J. Phys. **25** (8) 532-534 (1957). *Chem. Abstr.* **52** 7788 (1958).
Describes an apparatus for measuring the thermal conductivity of solids.
- 854.** A Gas-Blending System.
LANGER, A.
Rev. Sci. Instr. **18** (2) 101-103 (1947). *Chem. Abstr.* **41** 2613 (1947).
Describes and illustrates an apparatus for making accurately known blends of gaseous components, which may be used in mass spectrometry or i.r. for either calibration or checking purposes. The article deals mainly with hydrocarbons.
- 855.** Microsyringe for Small Liquid Volumes.
LANGER, S. H. and PANTAGES, P.
Anal. Chem. **30** (11) 1889-1890 (1958). *Chem. Abstr.* **53** 1866 (1959).
Describes, with a diagram, the modification of a syringe described in reference 889. The modified syringe will inject 3 μ l samples with a reproducibility of $\pm 1-3\%$.
- 856.** Gas-Liquid Chromatographic Separation of Phenols as Trimethylsilyl Ethers.
LANGER, S. H., PANTAGES, P. and WENDER, I.
Chem. and Ind. (London) 1958 (50) 1664-1665.
Relative retention volume data for 15 derivatives on both D.C. Silicone 550 and di-n-butyl tetrachlorophthalate on firebrick at 125°C are given in table form. Helium was used as carrier gas.

857. Bibliography on Gas Chromatography.

LANGER, S. H. and ZAHN, C.

Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.

Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 287.

A bibliography containing 442 references.

858. Gas-Liquid Chromatographic Resolution of *m*- and *p*-Xylene: Tetrahalophthalate Liquid Phases.

LANGER, S. H., ZAHN, C. and PANTAZOPOLOS, G.

Chem. and Ind. (London) 1958 (35) 1145.

Using helium as carrier gas, the retention volumes at 110°C on various tetrahalophthalate liquid phases are given for toluene, *m*-, *p*-, and *o*-Xylenes.

859. Sorption Processes—Granular Processes—Adsorption.

LAPIDUS, L.

Chem. Engng. Progr. **53** (11) 517 (1957).

The article includes a brief review and discussion on molecular sieves.

860. Mathematics of Adsorption in Beds. VI. The Effect of Longitudinal Diffusion in Ion Exchange and Chromatographic Columns.

LAPIDUS, L. and AMUNDSON, N. R.

J. Phys. Chem. **56** (8) 984-988 (1952). *Chem. Abstr.* **47** 9065 (1953).

Describes the derivation of equations in cases where the equilibrium is linear, for mass transfer at the surface of particles, and for local equilibrium.

861. Separation of Substances and Estimation of their Relative Molecular Sizes by the Use of Columns of Starch in Water.

LATHE, G. H. and RUTHVEN, C. R. J.

Biochem. J. **62** (4) 665-674 (1956). *Chem. Abstr.* **50** 12152 (1956).

It is suggested that columns of potato starch in buffer solutions may form a new type of partition column. Neutral molecules could be eluted in descending order of their molecular weights, giving a good resolution in the range 100-1,000. By using starch which had been swollen by warming in water, the column was made permeable to even larger molecules.

862. Chromatography.

LEDERER, E. and LEDERER, M.

Published by Elsevier Pub. Co. 1954.

A book giving a review of the principles and applications of chromatography which contains short sections on gas chromatography.

863. A New Ring Enlargement: Reaction of Nitrocycloalkanes with Lithium Aluminium Hydride.

LEE, G. E., LUNT, E., WRAGG, W. R. and BARBER, H. J.

Chem. and Ind. (London) 1958 (14) 417.

The reaction products and fractions were analysed by gas chromatography but no details were given.

864. Thermal Conductivity of Gas Mixtures.

LEHMANN, H.

Chem. Tech. (Berlin) **9** 530-537 (1957). *Chem. Abstr.* **52** 2484 (1958).

A number of formulae for the calculation of thermal conductivities are compared.

- 865.** An Integral-Detector for Chromatographic Analysis.
LEIBNITZ, E., HRAPIA, H. and KONNECKE, H. G.
Brennstoff-Chem. **38** (1) 14-16 (1957). *Chem. Abstr.* **51** 4877 (1957).
An integral-detector is described which is simple to use, and which gives an easily interpreted chromatogram. It is particularly useful in the separation of gases insoluble in KOH at room temperature.
- 866.** Instrumentation for Aerosols.
LEIGHTON, W. B.
Soap Chem. Specialities **34** (8) 79-81, 83, 89, 91 (1958). *Chem. Abstr.* **52** 17822 (1958).
A discussion of instruments, including those for gas chromatography.
- 867.** Practical Applications of Gas Chromatography.
LEITHE, W.
Osterr. Chem.-Ztg. **58** (11-12) 141-148 (1957). *Chem. Abstr.* **51** 16191 (1957).
A review giving 45 references.
- 868.** Labelling of Benzene with a Carbon-14 Ion Beam.
LEMMON, R. M., MAZZETTI, F., REYNOLDS, F. L. and CALVIN, M.
J. Am. Chem. Soc. **78** 6414-6415 (1956). *Chem. Abstr.* **51** 4973 (1957).
The products of reaction were separated by gas chromatography.
- 869.** Measurement and Correlation of Thermal Conductivities of Gases at High Pressure.
LENOIR, J. M., JUNK, W. A. and COMINGS, E. W.
Chem. Eng. Progr. **49** 539-542 (1953). *Chem. Abstr.* **48** 417 (1954).
Thermal conductivities were measured by passing heat through an annular layer of gas which was in series with a similar standard gas layer. Thermal conductivities of nitrogen, methane, argon and ethane are given at various temperatures.
- 870.** Petroleum.
LE TOURNEAU, R. L.
Anal. Chem. **29** (4) 684-697 (1957).
Some applications of gas chromatography in the petroleum industry are noted during the course of this review.
- 871.** Measurement of Thermal Conductivity of Gases using a Double Calorimeter.
LEVITS, G. M.
Pribory I. Tek. Eksp. 1958 102.
In Russian. The calorimeter which can be used for either gases, liquids or solids, has some special features. These include an hermetically sealed working chamber, and a uniform thickness of sample layer which can be measured after assembly. The latter may be varied if necessary by using interchangeable spacers.
- 872.** The Application of Isolative Vapour-Phase Chromatography and Mass Spectrometry to Problems of Odour Research.
LEVY, E. J., LAWREY, D. M. G., HERK, L. P. and STAHL, W. H.
Presented at 4th Annual Meeting ASTM Committee E-14 on Mass Spectrometry, Cincinnati, Ohio, 1956.
A method using both vapour-phase chromatography and mass spectrometry to identify the constituents of a multicomponent mixture is described. Details of a system for the collection of vapour-phase chromatography fractions are presented.

- 873.** Analysis of Ester-Type Plasticisers by Gas-Liquid Chromatography.
LEWIS, J. S. and PATTON, H. W.
Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.
Ed. COATES, V. J., NOBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958 145-153.
The analysis was carried out on glass columns packed with Apiezon Oil K on Celite 545, using helium as carrier gas and thermal conductivity detection. A table of relative elution times for known materials (phthalates etc.) is given, and some applications to commercial plasticisers are included.
- 874.** Qualitative Gas Chromatographic Analysis using Two Columns having Different Characteristics.
LEWIS, J. S., PATTON, H. W. and KAYE, W. I.
Presented at *Anal. Chem. Section of Southeastern Local Sections of A.C.S. Meeting, Columbia, South Carolina, November 1955.*
See the following reference.
- 875.** Qualitative Gas Chromatographic Analysis using Two Columns of Different Characteristics.
LEWIS, J. S., PATTON, H. W. and KAYE, W. I.
Anal. Chem. **28** (9) 1370-1373 (1956). *Chem. Abstr.* **50** 16533 (1956).
A member of a homologous series may often be identified by the time required for it to pass through a gas chromatography column, but if members of other series are present this time cannot positively identify a compound. Results of experiments using 2 columns are reported in this article.
- 876.** Coulometry Applied to Gas-Phase Chromatography.
LIBERTI, A.
Anal. Chim. Acta **17** (2) 247-253 (1957). *Chem. Abstr.* **52** 7005 (1958).
In English. A millicoulometer is described. The eluted components are absorbed in a suitable solution where they are continuously titrated by an electrolytically generated reagent.
- 877.** Coulometry Combined with Gas-Phase Chromatography for the Analysis of Volatile Mixtures.
LIBERTI, A. and CARTONI, G. P.
Atti. accad. nazl. Lincei. Rend., Classe sci. fis. mat. e nat. **20** 787-794 (1956). *Chem. Abstr.* **51** 12733 (1957).
The eluted constituents are passed through a combustion tube and the carbon dioxide formed determined by coulometric titration.
- 878.** Analysis of Essential Oils by Gas Chromatography.
LIBERTI, A. and CARTONI, G. P.
Gas Chromatography 1958. Amsterdam Symposium—May 1958.
Ed. DESTY, D. H. Published by Butterworths 1958. 321-328. Discussion 328-329.
A gas density balance apparatus together with a novel combustion coulometric titration detector have been used in this work, and a systematic examination of the monoterpenes occurring in essential oils carried out. See also the previous reference.
- 879.** Coulometric Microdetermination of Volatile Fatty Acids in Dairy Products as Separated by Vapour-Phase Chromatography.
LIBERTI, A., CARTONI, G. P. and PALLOTTA, U.
Il latte **30** 581-584 (1956). *Chem. Abstr.* **51** 13253 (1957).
The separated components were determined by coulometric titration as described in the previous 3 references.

- 880.** Coulometric Determination of Mercaptans Separated by Chromatography in the Gaseous Phase.
LIBERTI, A. and CARTONI, G. P.
Chim. e ind. (Milan) **39** (10) 821-824 (1957). *Chem. Abstr.* **52** 2664 (1958).
Describes the separation, identification and determination by the technique described in the previous references. The chromatographic column was packed with Silicone DC 550 containing stearic acid supporting on Celite.
- 881.** Application of Gas-Phase Chromatography to the Study of Essential Oils.
LIBERTI, A. and CONTI, L.
Riv. ital. essenze, profumi, piante, offic., oli vegetale, saponi **39** 128-134 (1957). *Chem. Abstr.* **51** 12440 (1957).
A comprehensive general review of the principles of gas-liquid chromatography and applications to perfumery materials. Chromatograms are given for commercial samples of limonene, dipentene, geranyl acetate, lemon and bergamot oils.
- 882.** Vapour-Phase Chromatography of the Methyl Esters of Fatty Acids and their Quantitative Determination in Fats by Automatic Electrometric Titration.
LIBERTI, A., CARTONI, G. P. and PALLOTTA, U.
Ann. chim. (Rome) **48** (1) 40-49 (1958). *Chem. Abstr.* **52** 9868 (1958).
The chromatographic column, which is thermostatically controlled between 25 and 300°C, is packed with glass powder containing 8% of silicone vacuum grease. Nitrogen is used as carrier gas, and the eluent is burnt to carbon dioxide which is determined electrometrically.
- 883.** Molecular Weight Determination of Components by Gas-Phase Chromatography.
LIBERTI, A., CONTI, L. and CRESCENZI, V.
Nature **178** (4541) 1067-1069 (1956). *Chem. Abstr.* **51** 4064 (1957).
See the following reference.
- 884.** Estimate of Molecular Weights of Constituents Identified with Gas-Phase Chromatography.
LIBERTI, A., CONTI, L. and CRESCENZI, V.
Atti accad. nazl. Lincei. Rend., Classe sci. fis. mat. e nat. **20** 623-629 (1956). *Chem. Abstr.* **51** 5808 (1957).
The apparatus used incorporated a gas density meter, and mixtures of hydrocarbons were separated. The results were discussed mathematically, and details of the theory and calculations were given.
- 885.** Applicability of the Infra-red Spectrophotometer as Analyser in Gas Chromatography.
LIBERTI, A., COSTA, G. and PAULUZZI, E.
Chimica. e industria (Milan) **38** (8) 674-677 (1955). *Chem. Abstr.* **50** 16534 (1956).
A propane-propene mixture was analysed with an error of about 1%. The separated hydrocarbons were oxidised to carbon dioxide before infra-red analysis.
- 886.** Gas-Liquid Partition Chromatography.
LICHTENFELS, D. H., FLECK, S. A. and BUROW, F. H.
Presented at Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, February 1955. Abstract in Anal. Chem. **27** (2) 328 (1955).
A general review of the subject with a discussion of some of its applications.

887. Gas-Liquid Partition Chromatography.

LICHTENFELS, D. H., FLECK, S. A. and BUROW, F. H.

Anal. Chem. **27** (10) 1510-1513 (1955). *Chem. Abstr.* **50** 4900 (1956).

A general article illustrated by the separation of a complex hydrocarbon mixture in the C_5 - C_8 range, and giving full details of the apparatus used. Detection was by thermal conductivity.

888. Gas Partition Analysis of Light Ends in Gasolines.

LICHTENFELS, D. H., FLECK, S. A., BUROW, F. H. and COGGESHALL, N. D.

Presented at Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy February 1956.

A rapid procedure for the analysis of C_3 - C_6 constituents of gasoline was described. The apparatus consisted of 2 columns in series, the first (1 ft long) acting as a stripping column to remove the heavy fraction, while the second (7 ft long) analysed the light fraction. A known amount of internal standard (diethyl ether) was added to the sample. The columns were packed with firebrick impregnated with 30% Octoil S and maintained at 45°C.

889. Gas Partition Analysis of Light Ends in Gasolines.

LICHTENFELS, D. H., FLECK, S. A., BUROW, F. H. and COGGESHALL, N. D.

Anal. Chem. **28** (9) 1376-1379 (1956). *Chem. Abstr.* **50** 17401 (1956).

See the previous reference.

890. Equilibrium Operation of Chromatographic Columns with Longitudinal Diffusion: Final Form Fronts.

LIGHTFOOT, E. N.

J. Phys. Chem. **61** 1686 (1957). *Chem. Abstr.* **52** 5088 (1958).

An equation was deduced from a mathematical analysis of longitudinal diffusion, which could be useful in the determination of equilibrium adsorption isotherms.

891. The Analysis of Volatile Liquid Mixtures by Thermal Conductivity Measurements on their Vapours.

LINDE, H. W. and ROGERS, L. B.

Anal. Chim. Acta **19** (4) 347-353 (1958).

The liquid is volatilised into a stream of nitrogen (or other inert gas), and the thermal conductivity of the resulting gas is measured. The detector, which comprises 3 precision resistors and 1 thermistor, is fully described.

892. Measurement of Small Quantities of Hydrocarbon in Water.

LINDGREN, C. G.

J. Am. Water Works Assoc. **49** 55-62 (1957). *Chem. Abstr.* **51** 5333 (1957).

A carbon tetrachloride extract of the water is separated chromatographically and the components identified by infra-red spectrometry.

893. Current Integration with Permanent Magnet D.C. Motors in Controlled Potential Coulometric Analysis.

LINGANE, J. J.

Anal. Chim. Acta **18** 349-352 (1958).

A d.c. motor integrator is described which is ideally suitable for a coulometer in controlled potential analysis.

894. Mechanic-Electric Transducer.

LION, K. S.

Rev. Sci. Instr. **27** (4) 222 (1956).

This device permits the conversion of mechanical displacements into electrical signals, and the system is based on the H.F. discharge in a gas under reduced pressure.

895. Atherosclerosis Break Through. Gas Chromatography Advances Lead to Quick Separation of Key Fatty Acids from Complex Lipids.

LIPSKY, S. R.

Chem. Eng. News **36** (5) 48 (1958).

The use of Reoplex 400, (commercial) polyoxyalkalene adipate, to separate unsaturated fatty acid esters in the C_{18} range is briefly described.

896. Techniques Used in a Study of the Boron and Silicon Hydrides.

LITTLEWOOD, A. B.

Presented at Symposium on Gas Chromatography, Soc. for Anal. Chem. Symposium, Scotland, May 1955. Abstract in Anal. Chem. **27** (10) 1667 (1955).

The general properties of these hydrides were outlined, and the gas chromatography apparatus used for their separation and analysis was described. No experimental details are given in the abstract.

897. An Examination of Column Efficiency in Gas-Liquid Chromatography, Using Columns of Wetted Glass Beads.

LITTLEWOOD, A. B.

Gas Chromatography 1958. Amsterdam Symposium—May 1958.

Ed. DESTY, D. H. Published by Butterworths 1958. 23-33. Discussion 33-35.

Reproducible columns of known characteristics can be made by using fine glass beads (about 0.1 mm diam) as support, on which liquid stationary phase up to about 3% by weight can be retained by surface tension. The efficiency of such columns was measured for various solutes as a function of quantity of solute, flow rate, temperature and retention volume.

898. The Chromatography of Gases and Vapours. V. Partition Analyses with Columns of Silicone 702 and of Tritolyl Phosphate.

LITTLEWOOD, A. B., PHILLIPS, C. S. G. and PRICE, D. T.

J. Chem. Soc. 1955 1480-1489. *Chem. Abstr.* **49** 10800 (1955).

A U-shaped column (1 m $\times$ 5 mm) is packed with the stationary phase supported on Celite 535, and is enclosed in an electrically heated vapour jacket. Nitrogen is used as carrier gas with thermal conductivity detection. Results are presented for alcohols, esters and aromatic hydrocarbons, and the efficiency of separation is discussed.

899. Here's How Gas Chromatography Works in the Laboratory.

LOCKE, L. N.

Oil Gas J. **56** (16) 120-121 (1958). *Chem. Abstr.* **52** 15883 (1958).

A description of the laboratory separation of naphthenes and aromatics, saturated and unsaturated hydrocarbons and pentanes. No experimental details are given in the abstract.

900. Method for Determining Thermal Conductivity at High Temperatures.

LONGMIRE, C. L.

Rev. Sci. Instr. **28** 904-906 (1957). *Chem. Abstr.* **52** 12538 (1958).

The described method was used to measure the thermal conductivity of graphite at ca 2,500°K.

- 901.** Gas Chromatography: A Means for Separation and Analysis of Volatile Materials.
LOTZ, J. R. and WILLINGHAM, C. B.
Ind. Hyg. Foundation Am. Trans. Bull. No. 30. 21st Ann. meeting. 195-200 (1956). *Chem. Abstr.* **51** 11157 (1957).
A general description of adsorption and partition gas chromatography, including column packings, eluent gases, detectors and retention times.
- 902.** Gas-Phase Chromatography.
LOTZ, J. R. and WILLINGHAM, C. B.
J. Chem. Educ. **33** (10) 485-498 (1956).
A general review covering the types of chromatography, apparatus and carrier gas, the operation of the apparatus and sample introduction. 23 references are given.
- 903.** Renewal of the Fatty Acids of Cholesterol Esters and Glycerides in the Liver and Plasma of the Normal Rat.
LOUEDEC, A.
Compt. rend. **246** 1619-1622 (1958). *Chem. Abstr.* **52** 16524 (1958).
Gas chromatography was used in this investigation, but no mention of this is given in *Chem. Abstr.* See the next reference.
- 904.** Nature of the Fatty Acids of Various Hepatic Lipids of the Rat.
LOUEDEC, A. and PASCAUD, M.
Compt. rend. **247** 1408-1411 (1958). *Chem. Abstr.* **53** 7357 (1959).
Using a column packed with 30% polyethylene glycol on Celite at 173°C, and a density balance as detector, it has been established that 60% of the fatty acids of phosphoglycerides are saturated (mainly stearic), and that 66% of the acids of glycerides and 80% of those of the esters of cholesterol are unsaturated (mainly oleic). Retention volumes of the various acids relative to methyl palmitate are given.
- 905.** A Sensitive Detector for Gas Chromatography.
LOVELOCK, J. E.
J. Chromatog. **1** (1) 35-46 (1958). *Anal. Abstr.* **5** 3208 (1958).
This paper describes a detector the method of operation of which is based on the unique ionisation properties of argon. Its sensitivity may be varied over a wide range, and it can detect as little as $2 \cdot 10^{-12}$ moles of organic substances. It is also relatively insensitive to temperature, pressure and gas flow rate.
- 906.** Measurement of Low Vapour Concentrations by Collision with Excited Rare Gas Atoms.
LOVELOCK, J. E.
Nature **181** (4621) 1460-1462 (1958). *Chem. Abstr.* **52** 19312 (1958).
The methods described possess the advantages of exceptional sensitivity and freedom from disturbances by changes in ambient temperature, pressure and flow rate, and as such should prove to be very suitable for use in gas chromatography.
- 907.** A Detector for Use with Capillary Tube Columns in Gas Chromatography.
LOVELOCK, J. E.
Nature **182** (4650) 1663-1664 (1958).
A small volume ionisation detector is described and illustrated. It has been tested with a metal capillary column 125 ft long $\times$ 0.01 in. diameter with a thin layer of squalane as stationary phase. An efficiency of 30,000 theoretical plates was observed in the separation of a $0.3 \mu\text{g}$ load of hydrocarbon vapours.

908. The 'Argon' Detector.

LOVELOCK, J. E.

Gas Chromatography 1958. *Amsterdam Symposium—May 1958.*

Ed. DESTY, D. H. Published by Butterworths 1958. 330. Discussion 330-332.

A short account of the argon β -ray ionisation detector presented at the symposium. It has already been described elsewhere. See reference 905.**909. Scintillation Counter for Measuring Radioactivity of Vapours.**

LOWE, A. E. and MOORE, D.

Nature **182** 133 (1958).

An instrument is described for counting the C14 content of vapours emerging from a gas chromatography apparatus in parallel with an analytical recorder.

910. The Selectivity Index and the Efficiency of the Chromatographic Column.
LU, P-C. and KWAN, Y-T.*Jan Liao Hsuen Pao* **3** 77-84 (1958). *Chem. Abstr.* **52** 16115 (1958).Russian summary. Calculations are derived from experiments using fine-pored silica gel as adsorbent in the analysis of a mixture of C_3H_8 , C_3H_6 , $n-C_4H_{10}$ and $\alpha-C_4H_8$.**911. Gas Chromatographic Separation of C_4 Hydrocarbons.**

LUCHSINGER, W.

Presented at Symposium on Gas Chromatography, Leipzig, October 1958. Preprints 197.In German. Only an abstract of this paper is given. The paper discusses separations of C_4 hydrocarbons using dimethyl formamide, tri-isobutylene, benzyl cyanide/ $AgNO_3$, dioctyl phthalate and cyclopentanone carboxylic acid ether ester.**912. Qualitative and Quantitative Analyses Through the Combined Technique of Ultra-violet and Chromatography.**

LUTINSKI, C.

Presented at 8th Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, March 1957. Abstract in Appl. Spectroscopy **11** (2) 100 (1957).

The use of an automatic recording u.v. spectrophotometer as a detector in chromatography is discussed.

913. The Quantitative Measurement and Transfer of Samples in Gas Chromatography.

McCREADIE, S. W. S. and WILLIAMS, A. F.

J. Appl. Chem. (London) **7** (1) 47-48 (1957). *Chem. Abstr.* **51** 13472 (1957).

The sample is sealed in a thin glass capillary tube and after insertion in the column can be broken without disturbing the carrier gas flow.

914. Cosmetic Knowledge through Instrumental Techniques.

McDONOUGH, E. G., MACKAY, D. A. M. and BERDICK, M.

J. Soc. Cosmetic Chemists **8** 126-138 (1957). *Chem. Abstr.* **51** 11660 (1957).

A review which includes the application of gas chromatography to problems in cosmetic chemistry.

915. Use of Mixed Stationary Liquids in Gas-Liquid Chromatography.

McFADDEN, W. H.

Anal. Chem. **30** (4) 479-481 (1958). *Chem. Abstr.* **52** 12466 (1958).

The separation of mono- and dibromoalkanes was carried out either on a 2-stage column containing (a) G.E. silicone oil SF-96 on C22 firebrick

and (b) Tween 60 (polyoxyethylene sorbitan monostearate) on C22 firebrick, or on a column containing a mixture of the 2 stationary phases on C22 firebrick. Helium was used as carrier gas.

916. Practical Notes on Gas-Liquid Chromatography as Applied to the Estimation of Volatile Fatty Acids.

McINNES, A. G.

I.P. Symposium, London, 1956. 304-315.

Ed. DESTY, D. H. Published by Butterworths 1957.

Describes modifications to the automatic titration apparatus of James and Martin. These include a polythene gland incorporating a mercury seal for the recording burette, an automatic switch-off device for the apparatus and a photoelectric unit which provides stable and full control for continuous operation.

917. Separation of Carbohydrate Derivatives by Gas-Liquid Partition Chromatography.

McINNES, A. G., BALL, D. H., COOPER, F. P. and BISHOP, C. T.

J. Chromatog. 1 (6) 556-557 (1958).

Separation of the fully methylated methyl glycopyranosides was accomplished on a Podbielniak 'Chromacon' using a column (8 ft $\times$ 7 mm I.D.) packed with Apiezon M/Celite 545 (1/4 w/w) at 170°C. Helium was used as carrier gas with katharometer detection.

918. The Volatile Acids of Mutton Fat.

McINNES, A. G., HANSEN, R. P. and JESSOP, A. S.

Biochem. J. 63 702-705 (1956). Chem. Abstr. 50 15795 (1956).

Using gas chromatography, the external fat of sheep has been proved to contain all the normal fatty acids from C_1 - C_{10} .

919. Separation of Organic Compounds by Means of Urea or Thiourea.

McKAY, D. L. and HUDDLESTON, J. G.

U.S. 2,763,637 (1956). Chem. Abstr. 51 3981 (1957).

By treatment with urea or thiourea, the separation of straight-chain hydrocarbons from branched-chain and/or cyclic hydrocarbons is possible.

920. Apparatus for Preparation of Very Dilute Gas Mixtures.

McKELVEY, J. M. and HOELSCHER, H. E.

Anal. Chem. 29 123 (1957). Chem. Abstr. 51 4767 (1957).

Describes the use of a diffusion cell for the preparation of gas mixtures.

921. Measurement of Composition of Freon 12/Freon 22 Mixtures with a Thermal Conductivity Gas Analyser.

McKOWN, H. S.

U.S. Atomic Energy Comm. K-1318 12 pp. (1957). Chem. Abstr. 51 12564 (1957).

The relative concentrations of the 2 compounds in admixture can be measured using a thermal conductivity cell. A full description of the apparatus is given.

922. Photochemical Studies. LIII. Isopropyl Iodide.

McMILLAN, G. R. and NOYES, W. A.

J. Am. Chem. Soc. 80 (9) 2108-2111 (1958). Chem. Abstr. 52 12570 (1958).

Gas chromatography was used to determine the purity of the isopropyl iodide, and also to determine the reaction products, which contained propane and propylene.

923. Mechanism of the Isomerisation of Cyclopropane.

McNESBY, J. R. and GORDON, A. S.

J. Chem. Phys. **25** (3) 582-583 (1956). *Chem. Abstr.* **51** 52 (1957).

The propylene formed by pyrolysis was readily separated from cyclopropane by gas chromatography using a 6 ft column of 1.5% squalane on carbon black. Helium was used as carrier gas, and the column temperature programmed from -196 to +40°C.

924. Photolysis and Pyrolysis of 2-Pentanone-1,1,1- d_3 .

McNESBY, J. R. and GORDON, A. S.

J. Am. Chem. Soc. **80** (2) 261-264 (1958). *Chem. Abstr.* **52** 6949 (1958).

The products were trapped and separated by gas chromatography on a 6 ft column of 1.5% squalane on carbon black. See the previous reference.

925. Synthesis of Butane-2,2,3,3- d_4 by the Photolysis of Diethylketone-2,2,4,4- d_4 .

McNESBY, J. R., DREW, C. M. and GORDON, A. S.

J. Phys. Chem. **59** 988-989 (1955). *Chem. Abstr.* **50** 7717 (1956).

Describes the separation of ethane, ethylene and butane by fractional desorption from silica gel with nitrogen. The components were determined by a thermal conductivity cell and mass spectrometry.

926. Mechanism of the Decomposition of Primary and Secondary Butyl Free Radicals.

McNESBY, J. R., DREW, C. M. and GORDON, A. S.

J. Chem. Phys. **24** 1260 (1956). *Chem. Abstr.* **50** 12612 (1956).

The products of reaction were separated by gas chromatography. See previous reference.

927. The Reaction of Methyl- d_3 Radicals with Cyclopropane and Cyclopentane.

McNESBY, J. R. and GORDON, A. S.

J. Am. Chem. Soc. **79** 825-826 (1957). *Chem. Abstr.* **51** 10387 (1957).

The products of the photolysis of acetone- d_6 and cyclopentane were examined by vapour-phase chromatography alone, whilst those of CD_3 radicals and cyclopropane were examined by vapour-phase chromatographic separation and mass spectrometry.

928. Reactions of CD_3 Radicals with the Butenes.

McNESBY, J. R. and GORDON, A. S.

J. Am. Chem. Soc. **79** 5902-5906 (1957). *Chem. Abstr.* **52** 3533 (1958).

The reaction products were analysed by gas chromatography using a 12 ft column packed with 1.5% squalane on Pelletex.

929. Vibration Packing of Dry Granular Solids.

MACRAE, J. C., FINLAYSON, P. C. and GRAY, W. A.

Nature **179** (4574) 1365-1366 (1957).

Variations in the porosity of a bed with variations in both amplitude and oscillating frequency were measured for powders passing a 300 B.S. sieve. Results obtained were described, discussed and also shown graphically.

930. Flame Ionisation Detector for Gas Chromatography.

McWILLIAM, I. G. and DEWAR, R. A.

Nature **181** (4611) 760 (1958). *Chem. Abstr.* **52** 11647 (1958).

Describes a detector in which use is made of the effect of organic vapours on the electrical conductivity of a hydrogen/nitrogen (1 : 1) flame. A double jet system is used, one jet acting as a reference jet.

931. Flame Ionisation Detector for Gas Chromatography.

McWILLIAM, I. G. and DEWAR, R. A.

Gas Chromatography 1958. *Amsterdam Symposium—May 1958.*

Ed. DESTY, D. H. Published by Butterworths 1958. 142-147. Discussion 147-152.

A new detector is described in which the ionisation of organic molecules in a flame is used as the method of detection. The electrical conductivity of the flame, burning a mixture of hydrogen and nitrogen in air is measured, and 2 forms of this detector are discussed. See also the previous reference.

932. Simple Bridge Method for the Measurement of Thermal Conductivity of Gases and Gas Mixtures.

MADAN, M. P.

J. Franklin. Inst. **263** 207-212 (1957). *Chem. Abstr.* **51** 7826 (1957).

No further information is given in *Chem. Abstr.*

933. A Method of Improving the Null-Point of Thermal Conductivity Cells for Gas-Liquid Chromatography.

MADDEN, W. F., QUIGG, R. K. and KEMBALL, C.

Chem. and Ind. (London) 1957 (26) 892. *Chem. Abstr.* **51** 14329 (1957).

The authors conclude that, for operation under sensitive conditions, it is most desirable to incorporate the appropriate fixed capacity and a third harmonic rejection filter when using thermal conductivity cells powered by a.c. in gas chromatography.

934. Analysis of Fixed and Condensable Gases by 2-Stage Gas Chromatography.

MADISON, J. J.

Advances in Gas Chromatography. A.C.S. Symposium—New York. September 1957. Published by A.C.S. 1957 D-97 to D-104. (Presented during 132nd Meeting, A.C.S.)

Two independent analyses on 2 different aliquots of the sample are carried out. The condensable vapours (C_2 - C_5) are resolved on a 50 ft gas-liquid partition column packed with dimethyl sulpholane on firebrick at 20°C, and the fixed gases separated on a 25 ft adsorption column of activated charcoal at 20°C. Helium was used as carrier gas in both cases and full experimental details are given. See the following reference.

935. Analysis of Fixed and Condensable Gases by 2-Stage Gas Chromatography.

MADISON, J. J.

Anal. Chem. **30** (11) 1859-1862 (1958). *Chem. Abstr.* **53** 2923 (1959).

Ethane, propane and butane were separated on a partition column (50 ft $\times$ $\frac{1}{4}$ in.) of dimethyl sulpholane on firebrick, and hydrogen, oxygen, nitrogen, carbon monoxide and methane were separated on an adsorption column (25 ft $\times$ $\frac{1}{4}$ in.) of activated charcoal. In both cases, thermal conductivity detection was used with helium as carrier gas.

936. Fractionation of Aromatic Hydrocarbons with Molecular Sieve Adsorbents.

MAIR, B. J. and SHAMAIENGAR, M.

Presented at 132nd Meeting, A.C.S. New York, September 1957. Abstract p. 7R No. 26.

The hydrocarbons are introduced on to the column, and the portion not adsorbed eluted with *isooctane*. The adsorbed portion is eluted from the

column by means of superheated steam or by ethyl alcohol at 75°C. See the following reference.

- 937.** Fractionation of Certain Aromatic Hydrocarbons with Molecular Sieve Adsorbents.

MAIR, B. J. and SHAMAIENGAR, M.

Anal. Chem. **30** 276-279 (1958). *Chem. Abstr.* **52** 7671 (1958).

The fractionation was carried out using Linde Molecular sieves types 10X and 13X.

- 938.** Statistical Methods in Chemistry.

MANDEL, J. and LINNIG, F. J.

Anal. Chem. **30** (4) 739-747 (1958). *Chem. Abstr.* **52** 9847 (1958).

Only the title is listed in *Chem. Abstr.* A review of the literature of statistics as applied to analytical chemistry. 289 references are included.

- 939.** Introduction to Vapour-Phase Chromatography.

MARECHAL, J.

Ind. chim. Belg. **22** (6) 675-682 (1957). *J. Appl. Chem.* **8** (10) Abstracts ii-441 (1958).

A general description of the principles and some of the applications of gas chromatography.

- 940.** Study of Catalytic Reactions by Means of Vapour-Phase Chromatography.

MARECHAL, J., CONVENT, L. and RYSELBERGE, J. van.

Rev. inst. franc. pétrole et Ann. combustibles liquides **12** 1067-1074 (1957). *Chem. Abstr.* **52** 4299 (1958).

Hall and Emmett's method (cf) was applied to a study of the isomerism of pentane, and the relative amounts of isopentane, unreacted pentane, and other products were determined by vapour-phase chromatography.

- 941.** Improvements in or Relating to Gas Chromatography.

MARTIN, A. E.

Brit. 790,217 (1958). *Chem. Abstr.* **52** 19726 (1958).

The eluted gases are converted to carbon dioxide and then analysed by infra-red spectrometry.

- 942.** Gas-Phase Chromatography.

MARTIN, A. E. and SMART, J.

Nature **175** 422-423 (1955). *Chem. Abstr.* **49** 9334 (1955).

Describes a detection method in which the eluted components are oxidised to carbon dioxide by passage through a tube of heated copper oxide, and then to an i.r. analyser which is sensitive to carbon dioxide only.

- 943.** Chromatography. Introduction.

MARTIN, A. J. P.

Brit. Med. Bull. **10** 161-162 (1954). *Chem. Abstr.* **49** 9428 (1955).

Only the title is listed in *Chem. Abstr.* An introduction to a series of articles on chromatography printed in a single issue of this *Bulletin*.

- 944.** Gas-Liquid Partition Chromatography. A Technique for Analysis of Volatile Materials.

MARTIN, A. J. P.

Kolloidzshr. **136** (1) 5 (1954). *Anal. Abstr.* **1** 2327 (1954).

The scope of the method is stated briefly.

945. Gas-Liquid Chromatography.

MARTIN, A. J. P.

Presented at Symposium on Gas Chromatography, Stevenston, Scotland, May 1955. Reported in Analyst **81** (1958) 52-53 (1956). *Abstract in Anal. Chem.* **27** (10) 1667 (1955).

A general review of the work of the author and A. T. James and a discussion of detection methods.

946. Gas-Liquid Chromatography.

MARTIN, A. J. P.

Experientia. Suppl. No. 5 21-32 (1956). *Chem. Abstr.* **51** 7221 (1957).

A report of a lecture giving 17 references.

947. Trends in Gas Chromatography.

MARTIN, A. J. P.

I.P. Symposium, London, 1956. 1-14.

Ed. DESTY, D. H. Published by Butterworths 1957.

An introductory talk, taking as its theme 'Where do we go from here?' Subjects discussed included column packings for use with higher temperatures, and the separation of inorganic substances.

948. Past, Present and Future of Gas Chromatography.

MARTIN, A. J. P.

ISA Journal **4** 563-566 (1957). *Chem. Abstr.* **52** 9713 (1958).

A general address, based on a paper given by the author at the 1st International Symposium on Gas Chromatography, Michigan State University, August 1957.

949. Past, Present and Future of Gas Chromatography.

MARTIN, A. J. P.

Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.

Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 237.

A general historical article on the development and uses of gas chromatography.

950. Recent Trends and New Developments.

MARTIN, A. J. P.

Gas Chromatography 1958. *Amsterdam Symposium—May 1958.*

Ed. DESTY, D. H. Published by Butterworths 1958. 139-141.

A review of the changes in gas chromatography which have taken place between the London Symposium in 1956 and the present Symposium.

951. Gas-Liquid Chromatography: The Gas Density Meter, A New Apparatus for the Detection of Vapours in Flowing Gas Streams.

MARTIN, A. J. P. and JAMES, A. T.

Biochem. J. **63** (1) 138-143 (1956). *Chem. Abstr.* **50** 13660 (1956).

Describes the design, construction and use of the gas density meter.

952. A New Form of Chromatogram.

MARTIN, A. J. P. and SYNGE, R. L. M.

Biochem. J. **35** 1358-1368 (1941). *Chem. Abstr.* **36** 5197 (1942).

This paper contains the first suggestion for what is now known as vapour-phase partition chromatography.

953. Determination of Benzene in Toluene.

MARTIN, F., COURTEIX, J. and VERTICALIER, S.

Bull. soc. chim. France 1958 (4) 494-496. *Chem. Abstr.* **52** 16126 (1958).

An estimate of the benzene content may be obtained from the temperature at which the first drop of distillate appears under strictly controlled conditions. A more accurate determination can be made by using gas chromatography with a column of tetraethylene glycol on firebrick and nitrogen as carrier gas.

954. Selective Micro Determination of the Alkoxy Group by Gas-Liquid Chromatography.

MARTIN, F. and VERTICALIER, S.

Presented at 15th Int. Congr. of Pure and Appl. Chem. Lisbon, September 1956.

No further details are available.

955. Thermal Conductivity Gas Analyser.

MATROSOVA, N. S.

Khim. Prom. 1956 422-425. *Chem. Abstr.* **51** 8482 (1957).

An analyser is described for the determination of hydrogen in ammonia synthesis gas, and for ammonia in recycle gas.

956. Experimental Accuracy in Quantitative Analysis by Gas Chromatography.

MAUREL, R.

Compt. rend. **244** (26) 3157-3159 (1957). *Chem. Abstr.* **51** 14465 (1957).

Since millivoltmeter readings do not exactly follow variations in voltage, a correction must be applied in the determination of mixtures of gases.

957. Materials for Gas Chromatography.*Booklet. Published by May and Baker Ltd. (1958). 23 pp.*

A free booklet giving standards and data for 'EMBAPHASE' stationary phases and 'EMBACEL' Kieselguhr. It includes a bibliography of 79 references. It was reviewed in *Perfumery Essent. Oil Record* **48** 385 (1957).

958. Ion Exchange as a Separations Method. IV. A Theoretical Analysis of the Column Separations Process.

MAYER, S. W. and TOMPKINS, E. R.

J. Am. Chem. Soc. **69** (11) 2866-2874 (1947). *Chem. Abstr.* **42** 3237 (1948).

A simple theoretical treatment of column performance, and a discussion of the general applicability of the theory.

959. Industrial Gas Sampling.

MEDLOCK, R. S. and WILSON, H.

Proc. Control and Automation **4** (11) 403 (1957).

A discussion of various types of sampling equipment and their application in industry.

960. Chromatographic Separation of Cracked Hydrocarbons.

MEDVEDEVA, N. I. and TORSUEVA, E. S.

Trudy Komissii Anal. Khim., Akad. Nauk S.S.S.R., Inst. Geokhim. i. Anal. Khim. **6** 88-96 (1955). *Chem. Abstr.* **50** 8185 (1956).

A mixture of hydrocarbons was separated on a column of silica gel which could be heated with a movable heater. Nitrogen or air was used as eluting gas, and detection was by means of an interferometer.

- 961.** Isotope Displacement by Adsorption and Desorption on Silica Gels at Low Temperatures and Pressures.

MELKONIAN, G. A. and REPS, B.

Z. Elektrochem. **58** 616-619 (1954). *Chem. Abstr.* **49** 7922 (1955).

The authors found that the vapour-phase of a mixture of H_2 and D_2 over silica gel was considerably enriched in the lighter isotope.

- 962.** Factors Affecting Katharometer Sensitivity and Column Efficiency in Vapour-Phase Partition Chromatography.

MELLOR, N.

I.P. Symposium, London, 1956. 63-73.

Ed. DESTY, D. H. Published by Butterworths 1957.

A study has been made of the factors affecting the sensitivity. The greatest sensitivity is obtained when the ambient temperature is the lowest possible consistent with avoiding condensation. A considerable increase in sensitivity is obtained by burning the emergent zones over copper oxide and measuring (at room temperature) the thermal conductivity of the carbon dioxide produced.

- 963.** The Mercury Photosensitised Exchange Reaction of Deuterium and Phosphine.

MELVILLE, H. W. and BOLLAND, J. L.

Proc. Roy. Soc. (London) A **160** (902) 384-406 (1937). *Chem. Abstr.* **31** 8378 (1937).

The analytical method employed consisted in measuring the thermal conductivity of the H_2/D_2 mixtures at high pressures by means of a gauge having a volume of 0.2 ml. The volume of gas required for analysis was 0.015 ml at NTP. The construction of the gauge is described.

- 964.** Gas Absorption Chromatographic Determination of some Oxygenated Products in Cool-Flame Combustion.

MENAPACE, H. R., KYRYACOS, G. and BOORD, C. E.

Advances in Gas Chromatography, A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D-153 to D-155. (Presented during 132nd Meeting, A.C.S.)

The separation of acetaldehyde, ethylene oxide, propylene oxide, propionaldehyde, acetone, acrolein, butyraldehyde and methyl ethyl ketone was carried out on a column of C22 firebrick containing 40% polyethylene 400 at 35°C using helium as carrier gas and thermal conductivity detection.

- 965.** Correlation of Thermal Conductivity Cell Response with Molecular Weight and Structure for Quantitative Gas Chromatographic Analysis.

MESSNER, A. E., ROSIE, D. M. and ARGABRIGHT, P. A.

Presented at Conf. on Anal. Chem., Pittsburgh, March 1958. Paper 144.

No further details are available.

- 966.** Use of Bentonite as Catalyst in the Oxidation of Toluene in the Vapour-Phase.

MEYER, H. and GARCIA, F. G.

Anales real. soc. espan. fis y quim. (Madrid) Ser. B, **53** 785-800 (1957). *Chem. Abstr.* **52** 11764 (1958).

The bentonite is activated with sulphuric acid of various strengths, and it was found that the efficiency of the catalyst varied with the degree of activation.

- 967. Routine Gas Chromatographic Analysis for Trace Materials.**
MEYER, R. A.
Presented at 8th Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, March 1957. Abstract in Appl. Spectroscopy **11** (2) 102 (1957).
Chromatograms are presented showing the effect on sensitivity of extending the following parameters to an unsatisfactory operating level during the analysis for trace components in natural gas:—detector voltage increase, sample volume increase, change in column length and change in flow rate. The separated trace components were identified by mass spectrometry.
- 968. The Analysis of High Vapour Pressure Natural Gasolines.**
MEYER, R. A.
Gas Chromatography—Instr. Soc. Am. Symposium—August 1957. Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 93–98.
A special 10-port sampling valve is described which permits direct sampling from high pressure liquid sample bombs. The analyses were carried out using a 21 ft $\times$ $\frac{1}{4}$ in. column packed with 25% eicosane on C22 firebrick, and a pre-cut column was used to divide the sample.
- 969. Versatile Micro-Catalytic-Chromatographic Instrument for Use in the Study of Catalysts.**
MICKEL, J. P.
Presented at 6th Annual Anachem. Conf., Detroit, October 1958.
No further details are available.
- 970. Simple and Multiple Gas Microintroducers for Adsorption Studies.**
MIGNOLET, J. C. P.
J. Sci. Instr. **30** (1) 15–17 (1953). *Chem. Abstr.* **47** 3624 (1953).
A full description of the instrument is given, and devices shown for varying the rate of flow and for multiple introductions.
- 971. Gas Chromatography: For Natural-Gas and Gasoline Analysis.**
MILLER, A. J.
Presented at N.G.A.A. Meeting, Shreveport, 1956. Reported in Oil Gas J. **54** (85) 126–127 (1956).
A short description of displacement and elution chromatography and its application to the analysis of natural gasoline, and to process monitoring.
- 972. How Gasoline Plants are Using Gas Chromatography.**
MILLER, A. J.
Oil Gas J. **56** (9) 88–91 (1958). *Chem. Abstr.* **52** 13237 (1958).
A discussion of process gas chromatographs, giving details of some of their applications.
- 973. Thermal Conductivity Bridge for Gas Analysis.**
MINTER, C. C. and BURDY, L. M. J.
Anal. Chem. **23** (1) 143–147 (1951). *Chem. Abstr.* **45** 3202 (1951).
Modifications to a conventional thermal conductivity bridge allow it to be used for 'convection' combined with 'conduction'. By this means it can be made specific for hydrogen or carbon dioxide. Full constructional and operational details are given.
- 974. Gas Chromatography.**
MIYAKE, H.
Kagaku no Ryoiki **11** 171–180 (1957). *Chem. Abstr.* **52** 16835 (1958).
A review containing 66 references.

- 975.** Analysis of Hydrogen Gases by Gas Chromatography.
MIYAKE, H.
Kagaku no Ryoiki **12** 627-630 (1958). *Chem. Abstr.* **52** 19339 (1958).
A symposium lecture article. No details are given in *Chem. Abstr.*
- 976.** Vapour-Phase Partition Chromatography. II.
MOGHADAME, P. E.
Rev. inst. franc. pétrole et Ann. combustibles liquids **12** 58-66 (1957).
Chem. Abstr. **51** 17302 (1957).
The construction of an apparatus is described and performance results reported. Thermal conductivities at 0° and 100°C are tabulated for 28 vapours and gases.
- 977.** Partition Chromatography in Vapour-Phase. II. Laboratory apparatus.
MOGHADAME, P. E.
Rev. inst. franc. pétrole et Ann. combustibles liquids **12** 58-66 (1957). *Chem. Abstr.* **51** 17302 (1957).
The construction of an apparatus, which uses nitrogen as carrier gas with thermal conductivity detection, is described. The thermal conductivities of several gases at 0° and 100°C are given.
- 978.** Definition of Chromatography.
MOKRUSHIN, S. G.
Nature **178** (4544) 1244-1245 (1956). *Chem. Abstr.* **51** 5501 (1957).
All varieties of chromatography can be divided into 2 groups, one in which the liquid or gas mixture flows through the layer of sorbant, and the other in which the dispersed sorbant settles or rises through a liquid or gas mixture.
- 979.** Gas Chromatography and its Application in the Analysis of Medicinals.
MOLLE, L. and VOGELENZANG, E. H.
Pharm. Weekblad. **93** 348-358 (1958). *Chem. Abstr.* **52** 14085 (1958).
In French. A review with 19 references which discusses the analysis of a tincture of orange peel, lobelia and myrrh.
- 980.** Sorption Processes—Adsorption, Dialysis and Ion Exchange.
MONET, G. P.
Chem. Engng. Progr. **53** (11) 514-517 (1957). *Chem. Abstr.* **52** 1698 (1958).
No details are given in *Chem. Abstr.*, but the paper is a review and introduction to the subject, and contains useful information on porosity, adsorption and other properties of adsorbents.
- 981.** Some Applications of Gas Chromatography to Commonly Encountered Analytical Problems.
MONKMAN, J. L.
Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.
Ed. COATES, V. J., NOBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 111-115.
Describes the application of gas chromatography to problems of Occupational Health, such as unhygienic working conditions arising in the handling of solvents, dry cleaning fluids, paint thinners and degreasing solvents.
- 982.** Vapour-Phase Chromatography.
MOORE, W. R.
Presented at Joint Meeting of Organic and Medicinal Chem. Divisions of A.C.S., Minneapolis, Minnesota, September 1955.
A review which discusses the principles and operation of the procedure and compares it with adsorption and partition chromatography. Its application to organic chemistry is indicated.

983. The Separation of Orthohydrogen and Parahydrogen.

MOORE, W. R. and WARD, H. R.

J. Am. Chem. Soc. **80** (11) 2909-2910 (1958). *Chem. Abstr.* **52** 17893 (1958).

These isomers were separated on a column of activated alumina at 77°K, using purified helium as carrier gas, and thermal conductivity detection. (*Chem. Abstr.* wrongly reports the carrier gas as hydrogen.) If the column is properly activated, no irreversible adsorption takes place.

984. A. J. P. Martin and A. T. James and the Development of Gas Chromatography.

MOORE, S.

J. Soc. Cosmetic Chemists **8** 270-276 (1957).

Gives an account of biographical and appreciative remarks on the presentation of a Diploma to Martin and James by the Society of Cosmetic Chemists, and their replies.

985. Need Help with Gas Chromatography?

MORROW, H. N. and BUCKLEY, K. B.

Petrol. Refiner **36** (8) 157-161 (1957). *Chem. Abstr.* **51** 15338 (1957).

Saturated hydrocarbons may be separated on columns of vacuum pump oil or benzyl benzoate on Celite, and unsaturated hydrocarbons on activated alumina modified with silicone oil, dimethyl- and diethylformamide, and on hexamethyl phosphoramidate on Celite.

986. Note on Gaseous Radiochromatography.

MOUSSEBOIS, C. and DUYCKAERTS, G.

J. Chromatog. **1** (2) 200-201 (1958). *Chem. Abstr.* **52** 18067 (1958).

Alkyl iodides labelled with I^{131} were separated on a column containing fire-brick impregnated with dinonyl phthalate, using nitrogen as carrier gas. The apparatus used is described and illustrated.

987. Chromatographic Analysis of Gases and Vapours.

MUENSTER, H. K.

Lab. sci. (Milan) **6** 12-23 (1958). *Chem. Abstr.* **52** 16005 (1958).

A review giving 15 references.

988. Portable Apparatus Analyses Multicomponent Mixtures by Fractional Separation of Vapours in Partition Columns.

MULLER, R. H.

Anal. Chem. **27** (6) 33A-36A (1955).

A description is given of a portable gas chromatography apparatus.

989. Gas Chromatography.

MULLER, R. H.

Anal. Chem. **27** (6) 33A-36A (1955).

A review of the subject with particular reference to the Perkin-Elmer Vapour Fractometer.

990. Vapour-Phase Chromatography Used to Perform Automatic Analyses.

MULLER, R. H.

Anal. Chem. **29** (3) 55A-57A (1957).

A review of the Shandon flame chromatograph, which uses the hydrogen flame detector described by Scott.

- 991.** Vapour-Phase Chromatography Advancing Rapidly.
MULLER, R. H.
Anal. Chem. **29** (10) 67A-68A (1957).
Description of a new Podielniak model—Chromatographette Series 9490.
- 992.** Detection of Sample Fractions in Vapour-Phase Chromatography.
MUNCH, R. H.
Presented at Conf. on Anal. Chem. and Appl. Spectroscopy, Pittsburgh, March 1956.
No further details are available, but see the next reference.
- 993.** Detection of Sample Fractions in Vapour-Phase Chromatography.
MUNCH, R. H.
Presented at 129th National A.C.S. Meeting, Dallas, Texas, April 1956. Abstracts p. 14B No. 38.
The properties which ideal detectors should have are discussed, and available detectors are examined to see which best comply with these requirements. All types of detector are considered.
- 994.** Vapour-Phase Chromatography.
MUNCH, R. H.
Record. Chem. Progr. **18** 69-101 (1957). *Chem. Abstr.* **51** 12598 (1957).
A review of the subject containing 14 references.
- 995.** Thermoconductometric Analysis of Gases.
MUND, W., Van MEERSSCHE, M. and GUIDEE, C.
Bull. classe sci. Acad. roy. Belg. **39** 676-683 (1953). *Chem. Abstr.* **48** 2516 (1954).
The apparatus and technique are fully described. 3 identical cells are used in 1 thermostat in order to eliminate small variations in potential and temperature.
- 996.** Properties of the Martin Gas Density Balance and Possible Modifications Thereof.
MUNDAY, C. W. and PRIMAVESI, G. R.
I.P. Symposium, London, 1956. 146-153.
Ed. DESTY, D. H. Published by Butterworths 1957.
An electrical analogue of the system is described for evaluating performance. The theoretical results of modifications in design are discussed and some practical results of the modifications are described.
- 997.** The Determination of Small Amounts of γ -Picoline in Aqueous Solutions of β -Picoline by Vapour-Phase Chromatography.
MURRAY, W. J. and WILLIAMS, A. F.
Chem. and Ind. (London) 1956 (38) 1020-1021. *Chem. Abstr.* **51** 2473 (1957).
No appreciable separation of the picolines was obtained by James and Martin using columns of silicone DC 550, Lubrol MO, or liquid paraffin. The present authors have found however, that the separation can be accomplished on a column (4 ft $\times$ 4 mm) of Celite 545 impregnated with glycerol at 78°C, using nitrogen as carrier gas.
- 998.** Modern Separation Methods in Chemistry.
MUSSO, H.
Naturwissenschaften **45** 97-104 (1958). *Chem. Abstr.* **52** 11518 (1958).
A review of chromatography, electrophoresis and ion exchange containing 23 references.

999. Cosmetic and Toilet Preparations.

MYDDLETON, W. W.

Mfg. Chemist. **28** 330-332 (1957). *Chem. Abstr.* **51** 17106 (1957).

A discussion of the use of gas chromatography in the testing of such preparations.

1000. A Multiple Fraction Collector for Gas Chromatography.

NAPIER, I. M. and RODDA, H. J.

Chem. and Ind. (London) 1958 (41) 1319. *Chem. Abstr.* **53** 5771 (1959).

Full details of the construction and operation of this device are given. A diagram is included.

1001. Citronellol (Rhodinol) and Geraniol in Geranium and Rose Oils.

NAVES, Y. R.

Perfumery Essent. Oil Record **48** 118-120 (1957). *Chem. Abstr.* **51** 12439 (1957).

The technique is not fully satisfactory for the isolation of components, but is suitable for the analysis of small samples. 19 references are given.

1002. Nature of the Fixed Phase or of the Carrier in Gas-Liquid Partition Chromatography of Essential Oils and Aromatics.

NAVES, Y. R.

J. Soc. Cosmetic Chemists **9** (2) 101-103 (1958). *Chem. Abstr.* **52** 10507 (1958).

Suitable high temperature stationary phases for essential oils are discussed. As diatomaceous earths react with essential oil constituents, sea sand and NaCl are recommended as supports. Powdered glass is not suitable. Reactions at katharometer wires are reported and dehydration of alcohols quoted as an example.

1003. The Nature of the Fixed Phase or of the Carrier in Gas-Liquid Partition Chromatography of Essential Oils and Aromatics.

NAVES, Y. R.

Am. Perfumer Aromat. **71** (5) 38 (1958). *Chem. Abstr.* **52** 12330 (1958).

See the previous reference.

1004. Composition of Anethole.

NAVES, Y. R.

Parfums, cosmet, savons. **1** 219-221 (1958). *Chem. Abstr.* **52** 15831 (1958).

It is possible to determine *cis*- and *trans*-anethole and estragole in mixtures, and thus determine the origin of anethole samples. No experimental details are given.

1005. Analytical Distinctions Between Lavender and Lavandin Oils.

NAVES, Y. R.

Compt. rend. **246** 2163-2165 (1958). *Chem. Abstr.* **52** 14979 (1958).

Oils of lavender and lavandin may be distinguished by the presence of camphor in the latter —0.25% may be detected. Components are eluted from a column of Perkin-Elmer 'C' in the order:—linalol, linalyl acetate, camphor, borneol and α -terpinol, geraniol, bornyl acetate, terpinyl acetate and geranyl acetate.

1006. Determination of *Cis*-Anethole in Essential Oils and in Preparations of Anethole.

NAVES, Y. R.

Compt. rend. **246** 1734-1736 (1958). *Chem. Abstr.* **52** 14091 (1958).

In the gas chromatography of a mixture of *cis*-anethole, *trans*-anethole and estragole, 3 distinct peaks are obtained, permitting the determination of the 3 constituents of the mixture.

- 1007.** Analysis of Rose Oils by Vapour-Phase Partition Chromatography and Infra-red Spectroscopy.

NAVES, Y. R.

Perfumery Essent. Oil Record **49** 290-296 (1958). *Chem. Abstr.* **52** 19020 (1958).

Curves for 4 Bulgarian (1 adulterated), 2 Turkish Rose oils, and a Provence Rose de Mai Absolute are reproduced and compared. Components are eluted from a Perkin-Elmer 'C' column in the order:—ethanol, *n*-nonanol, phenylethyl alcohol, rhodinol and nerol together, geraniol, methyl eugenol, eugenol and stearoptenes. Adulteration with synthetic citronellol can be detected by the dihydro-citronellol peak which appears just before rhodinol.

- 1008.** Volatile Vegetable Matters. CXLIX. Use of Gas-Liquid Partition Chromatography in the Analysis of Mixtures of Citrals and of Certain of their Isomeric Derivatives.

NAVES, Y. R. and ODERMATT, A.

Bull. soc. chim. France 1958 (3) 377-384. *Chem. Abstr.* **52** 12968 (1958).

The column used (3.6 m $\times$ 0.45 cm) is packed with a Perkin-Elmer 'C' absorption charge, which has a weak polarity and can be used up to 225°C. The carrier gas is hydrogen and detection is by thermal conductivity.

- 1009.** Application of Gas-Liquid Chromatography to the Determination of Eugenol in Various Essential Oils.

NAVES, Y. R. and ODERMATT, A.

La France et ses Parfums, **1** 10 (October 1958).

The quantitative determination of eugenol and its acetate in clove bud, leaf and stem oil, in cinnamon oil and in oils of *Ocimum gratissimum* L is described in detail. Chromatograms for clove leaf oil before and after adulteration with methyl eugenol, and of cinnamon bud oil adulterated with methyl eugenol, are reproduced.

- 1010.** The Analysis of Essential Oils by Gas-Liquid Partition Chromatography, Particularly those of Citronella and Lemongrass.

NAVES, Y. R. and ODERMATT, A.

Compt. rend. **247** 687-689 (1958). *Chem. Abstr.* **53** 3608 (1959).

Citronellal, citronellol and geraniol in citronella oil, and citrals *a* and *b* in lemongrass oil, are determined using benzyl acetate, which emerges from a Reoplex 100 column between citronellal and citronellol, as internal standard.

- 1011.** Chromatographic Determination of Acetylene and Diacetylene in the Presence of Mono-Substituted Acetylenes.

NEBBIA, L. and PAGANI, B.

Chimica e industria (Milan) **37** (3) 200-201 (1955). *Chem. Abstr.* **49** 11503 (1955).

Acetylene and diacetylene are deposited near the head of a column containing alumina (96 parts) and cuprous chloride (4 parts). Other acetylenes are deposited at the lower end of the column.

- 1012.** Polarographic Vessel for Continuous Gas Analysis.

NEDOROST, M.

Chem. Listy. **50** 317-318 (1956). *Chem. Abstr.* **50** 6209 (1956).

The apparatus described has been used in gas chromatography.

- 1013.** Determination of Surface Area. Adsorption Measurements by a Continuous Flow Method.

NELSEN, F. M. and EGGERTSEN, F. T.

Anal. Chem. **30** (8) 1387-1390 (1958). *Chem. Abstr.* **52** 16833 (1958).

Nitrogen is adsorbed by the sample at liquid nitrogen temperature from a gas stream of nitrogen and helium, and eluted upon warming the sample. The nitrogen liberated is measured by thermal conductivity. Good agreement is obtained with conventional volumetric methods.

- 1014.** Chemical Analysis of Tomorrow.

NIEUWENBURG, C. J. Van.

Chim. anal. **38** (12) 423-427 (1956). *Chem. Abstr.* **51** 4865 (1957).

A review of instrumental developments in automatic chemical analysis.

- 1015.** Radiation Chemistry of Cyclohexane.

NIXON, A. C. and THORPE, R. E.

J. Chem. Phys. **28** 1004-1005 (1958). *Chem. Abstr.* **52** 15268 (1958).

Gas-liquid chromatography and spectroscopy were used to separate and identify the liquid reaction products from the gamma irradiation of cyclohexane.

- 1016.** Gas Chromatographic Analysis of the Purest Ethylene.

NODOP, G.

Presented at Meeting on 'The Analysis of Gaseous and Liquid Hydrocarbons and their Derivatives by Physical Methods', Essen. Janary 1958. Printed in Z. anal. Chem. **164** (1) 120-126 (1958).

In German. Ethylene was analysed with columns of tetraisobutylene on Celite, molecular sieve 13X and silica gel. With samples of 5 or 25 ml on combinations of these columns, the following impurities were determined in concentrations ranging from 5-100 ppm: H_2 , O_2 , N_2 , CO , CO_2 , CH_4 , C_2H_6 , propane, propylene and C_4 hydrocarbons.

- 1017.** Programmed Temperature Gas Chromatography.

NOGARE, S. D. and BENNETT, C. E.

Anal. Chem. **30** (6) 1157-1158 (1958). *Chem. Abstr.* **52** 16972 (1958).

The column temperature is raised linearly during separations and each solute is thus eluted at a definite volume and temperature. 7 hydrocarbons from pentane to 1-tetradecene were separated on a column of Chromosorb impregnated with 25% DC-200 silicone oil, using helium as carrier gas.

- 1018.** High Temperature Gas Chromatography Apparatus.

NOGARE, S. D. and SAFRANSKI, W. L.

Presented at Southwide Chem. Conf. on Instrumentation, Instr. Soc. Am. Symposium on Gas Chromatography, Memphis, Tennessee, December 1956. See the next reference.

- 1019.** High Temperature Gas Chromatography Apparatus.

NOGARE, S. D. and SAFRANSKI, W. L.

Anal. Chem. **30** (5) 894-898 (1958). *Chem. Abstr.* **52** 13326 (1958).

Columns of Celite 545 impregnated with high vacuum silicone grease were operated at 150-350°C. The platinum katharometer filaments are gold-soldered to tungsten supports, and operated at a higher temperature than the column to avoid condensation. Helium was used as carrier gas, and the separation of some mixtures of C_{10} - C_{18} paraffins, ethylene glycols, phthalates and adipates is described.

1020. Analytical Separations.

NOGARE, S. D. and SAFRANSKI, L. W.

Presented at a Symposium on 'An Analysis Group in an Industrial Research Organisation'. Reported in J. Chem. Educ. **35** (1) 14-17 (1958). *Chem. Abstr.* **52** 4381 (1958).

Only the title is listed in *Chem. Abstr.* A short review of analytical separations using 3 methods, reaction, liquid-liquid partition chromatography and gas chromatography. Chromatograms are given showing the separation of a sample of monomethyl butylamine on Celite impregnated with 25% 2-ethyl hexanediol-1,3 at 87°C, the ppm analysis of cyclohexane in water and of cyclohexanol in toluene, the separation of ethylene glycols and of dialkyl phthalates.

1021. A Simple Electromechanical Integrator.

NOGARE, S. D., BENNETT, C. E. and HARDEN, J. C.

Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.

Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 117-128. Discussion 128-129.

A simple integrator is described for measuring peak areas. Full details of the principle and operating procedure are given, and performance characteristics are evaluated.

1022. Null-Adjusting Device for Gas Analysers.

NOMURA, I. and KAGA, S.

Jap. Pat. 2750 (1955). *Chem. Abstr.* **51** 12571 (1957).

A null-adjusting device for use with thermal conductivity cells is described.

1023. A Combustion Device for Use in Conjunction with Chromatographic Columns.

NOREM, S. D.

Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.

Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 191-194.

The use of a copper oxide combustor to convert hydrocarbons to carbon dioxide was discussed and investigated. It was found that the amplification obtained was not as high as was predicted theoretically, and this was explained.

1024. 2:4:7-Trinitrofluorenone as a Stationary Phase in Gas Chromatography.

NORMAN, R. O. C.

Proc. Chem. Soc. 1958 151. *Chem. Abstr.* **52** 17892 (1958).

The compound in the form of a liquid film coated on firebrick, can be used at temperatures up to 200°C, and provides a suitable stationary phase for the resolution of certain isomeric benzene derivatives, being particularly effective in the resolution of compounds of the naphthalene series. Nitrogen is used as carrier gas, since the compound is reduced by hydrogen.

1025. Non-Ideal Effects Upon Elution Curve Shape in Vapour-Partition Chromatography.

NORRIS, T. G. and CROSSER, O. K.

Advances in Gas Chromatography—A.C.S. Symposium, New York. September 1957. Published by A.C.S. 1957. D-15 to D-26. (Presented during 132nd Meeting, A.C.S.)

A mainly theoretical paper in which theories relating elution curve shape to operating variables are reviewed and reasons given for the increasing

asymmetry of elution curves with larger sample volumes. Non-ideal effects are also considered, and optimum operating conditions are deduced from the results of the experiments described.

1026. Separation of Esters of Mono- and Dicarboxylic Fatty Acids by Gas-Liquid Chromatography.

NOWAKOWSKA, J., MELVIN, E. H. and WIEBE, R.

Presented at Meeting of American Oil Chemists' Soc., Chicago, September 1956. Abstract in Anal. Chem. **28** (12) 2027 (1956).

The apparatus was described, and the compounds separated listed, but no experimental details are given in the abstract. See also the following reference.

1027. Separation of the Oxidation Products of Fatty Acids by Means of Gas-Liquid Partition Chromatography.

NOWAKOWSKA, J., MELVIN, E. H. and WIEBE, R.

J. Am. Oil Chemists' Soc. **34** (8) 411-414 (1957). *Chem. Abstr.* **51** 15149 (1957).

These products were separated on a column (75 in. $\times$ 8 mm) of Celite 545 impregnated with D.C. Silicone high vacuum grease, at temperatures up to 250°C. Helium was used as the carrier gas with thermal conductivity detection. The detector temperature was 197°C.

1028. Analysis of Hydrocarbon Blends by Gas-Liquid Partition Chromatography.

NUNEZ, L. J., ARMSTRONG, W. H. and COGSWELL, H. W.

Anal. Chem. **29** (8) 1164-1165 (1957). *Chem. Abstr.* **51** 15930 (1957).

Nine blends of known composition were analysed, and the proportion of each component was calculated from the ratio of its peak area to the total area of all peaks. The blends were analysed on 2 columns in series, the first containing didecyl phthalate on Celite, and the second, ethyl hexyl sebacate on Celite. Helium was used as carrier gas with a thermistor type thermal conductivity cell. Depending on the volatility of the blends, the analyses were run at 50°, 100° or 120°C.

1029. Thermal Conductivity of Nitrogen from 50°-500°C, and 1-100 Atmospheres.

NUTTALL, R. L. and GINNINGS, D. C.

J. Research Natl. Bur. Standards **58** 271-278 (1957) (*Research Paper* 2760). *Chem. Abstr.* **51** 11834 (1957).

The method of determination was described, and equations representing the experimental results obtained, were deduced.

1030. Separation of Allylic Bromides without Isomerisation by Gas Chromatographic Techniques.

NYSTROM, R. F. and BERGER, C. R. A.

Chem. and Ind. (London) 1958 (19) 559-560. *Chem. Abstr.* **53** 2069 (1959).

These compounds were separated on a 2 m column of dodecylphthalate on Celite in a Perkin-Elmer Vapour Fractometer at 48-68°C, using helium as carrier gas.

1031. The Interrelationship of Column Efficiency and Resolving Power in Gas Chromatography.

OBER, S. S.

Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.

Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 41-50.

A knowledge of the rating of solvents in terms of both their efficiency and their resolving power makes the choice of solvent for a particular separation much easier and more precise. It can also provide a check on column packing uniformity and efficiency, and enable more accurate predictions of separation ability to be made for unknown solutes.

1032. The Chromatographic Separation of Aromatic Hydrocarbons from their Mixtures with Organic Sulphur Compounds.

OBOLENTSEV, R. D. and AYVAZOV, B. V.

Doklady Akad. Nauk. S.S.S.R. **114** (4) 803-806 (1957). *Chem. Abstr.* **52** 832 (1958).

Describes the use of columns of silica gel, activated carbon and alumina. Aromatic hydrocarbons may be isolated from petroleum oils by this method.

1033. Solid and Gaseous Fuels. Industrial Applications of Analysis, Control and Instrumentation.

ODE, W. H.

Anal. Chem. **29** (4) 657-669 (1957). *Chem. Abstr.* **57** 7219 (1957).

Only the title is listed in *Chem. Abstr.* The article contains a section (p. 666) on gas chromatography as applied to gaseous fuels.

1034. Separating Asphalt into its Chemical Constituents.

O'DONNELL, G.

Anal. Chem. **23** (6) 894-898 (1951). *Chem. Abstr.* **45** 8240 (1951).

Long chain paraffins present were separated by means of urea-complex formation. A longer abstract is given in *Chem. Abstr.*

1035. Exploratory Studies of High-Temperature Gas-Liquid Chromatography.

OGILVIE, J. L., SIMMONS, M. C. and HINDS, G. P.

Presented at 131st Nat. Meeting A.C.S. Miami, Florida, April 1957. Abstracts 19Q No. 61.

An apparatus has been designed for operation at up to about 400°C. Preheater, column and detector are all cast in an aluminium block and heated electrically. Petroleum derived asphaltenes can be used as stationary phases, and higher boiling petroleum fractions may be analysed, using helium as carrier gas with thermal conductivity detection.

1036. Exploratory Studies of High-Temperature Gas-Liquid Chromatography.

OGILVIE, J. L., SIMMONS, M. C. and HINDS, G. P.

Am. Chem. Soc., Div. Petrol. Chem., Gen. Papers **2** (1) 411-416 March 1957.

See the previous reference.

1037. Exploratory Studies of High-Temperature Gas-Liquid Chromatography.

OGILVIE, J. L., SIMMONS, M. C. and HINDS, G. P.

Anal. Chem. **30** (1) 25-27 (1958). *Chem. Abstr.* **52** 7925 (1958).

See the previous two references.

- 1038.** Construction of Gas-Adsorption Chromatography and its Application. OHKOSHI, S., FUJITA, Y. and KWAN, T.
Catalyst No. 15. 1-10. March 1958.
In Japanese with an abstract in English. A conventional apparatus was constructed and used for the gas-adsorption chromatography of air, CO, CH₄, C₂H₂, CO₂, C₂H₄ and C₂H₆. Activated carbon was used as column material with hydrogen as carrier gas.
- 1039.** Gas Chromatographic Separation of Hydrogen Isotopes D₂ and HD. OHKOSHI, S., FUJITA, Y. and KWAN, T.
Bull. Chem. Soc. Japan **31** (6) 770-771 (1958). *Chem. Abstr.* **53** 13869 (1959).
In English. The isotopes are separated in a glass U-tube, 80 cm long and 0.3 cm I.D., filled with Linde molecular sieve 5A. The column is immersed in a liquid nitrogen bath when in use. Detection is by means of a thermal conductivity cell having a thermistor, and hydrogen is used as carrier gas.
- 1040.** Gas Chromatography as a New Tool for Analysis of Hydrogen Isotopes. OHKOSHI, S., TENMA, S., FUJITA, Y. and KWAN, T.
Bull. Chem. Soc. Japan **31** (6) 772 (1958). *Chem. Abstr.* **53** 9883 (1959).
In English. See previous abstract for method and apparatus. This paper gives a short account of preliminary experiments carried out to make the analysis quantitative. It is concluded that gas chromatography may replace, to some extent, mass spectrometry for this determination.
- 1041.** Enrichment of Deuterium by Low Temperature Gas-Adsorption Chromatography. OHKOSHI, S., TENMA, S., FUJITA, Y. and KWAN, T.
Bull. Chem. Soc. Japan **31** (6) 773-774 (1958). *Chem. Abstr.* **53** 9842 (1959).
In English. The apparatus and column packing used were as in the previous abstract, and experiments showed that D₂ may be enriched simply and efficiently from a mixture of H₂, HD and D₂ by this method.
- 1042.** Guide to Process Instrument Elements. OLIVE, T. R. and DANATOS, S.
Chem. Eng. **64** (6) 287-320 (1957). *Chem. Abstr.* **51** 11775 (1957).
Only the title is listed in *Chem. Abstr.* Details of a large number of instruments are given, including those for measurement of temperature, pressure, pH, electrical conductivity, thermal conductivity, humidity of gases, and for use with gas chromatography.
- 1043.** Separation of Polyunsaturated Fatty Acid Methyl Esters by Gas Chromatography. ORR, C. H. and CALLEN, J. E.
J. Am. Chem. Soc. **80** (1) 249 (1958). *Chem. Abstr.* **52** 7032 (1958).
These esters were separated on a column (12 ft x $\frac{1}{4}$ in.) of Celite 545 impregnated with 30% Reoplex 400 plasticiser at 240°C, using helium as carrier gas with thermal conductivity detection.
- 1044.** Adsorption Selectivity in Adsorption Chromatography. OSCIK, J. and WAKSMUNDZKI, A.
Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. AA **9** 9-34 (1954) (Published 1956). *Chem. Abstr.* **51** 5501 (1957).
Factors affecting the process of adsorption are discussed, and an expression is derived for the selectivity of adsorption. A much fuller abstract is given in *Chem. Abstr.*

1045. Measurement of Concentration in Gases.

OSTER, H.

G.P. 42L, 4/16 S34914.

Describes an arrangement for measuring the variation in the concentration of a gas. It includes a magnetic or electric bridge having 2 branches, 1 for a standard gas sample and the other for the unknown gas sample.

1046. Thermal Conductivity-Reduced-State. Correlation for the Inert Gases.

OWENS, E. J. and THODOS, G.

A.I.Ch.E. Journal 3 (4) 454-461 (1957). *Chem. Abstr.* 52 3438 (1958).

Thermal conductivity data for argon available in the literature have been correlated and compared.

1047. Calcium Purification of Noble Gases.

PACHUCKI, C. F. and YETTER, L. R.

U.S. Atomic Energy Comm. KAPL-1453.

Calcium metal at 650-700°C is used in conjunction with a cycling technique to purify noble gases, thereby effecting more accurate mass spectrometric analysis. The gases used consisted of mixtures of inert gases and CH₄, NH₃, N₂, CO, CO₂, N₂O and SO₂. A total removal of 99.9% of reactive gases was accomplished and the distribution of inert gases in air has been determined by this method.

1048. Thermal Conductivity Method for Gas Analysis.

PALMER, P. E. and WEAVER, E. R.

U.S. Bur. Stds. Tech. Paper 18, No. 249 35-100 (1924). *Chem. Abstr.* 18 1099 (1924).

A full description of the method is given.

1049. Gas Chromatography as Applied to the Industrial Separation of Nitrogen and Helium from Neon.

PAOLINO, V. J.

Proc. Cryogenic Eng. Conf., 2nd, Boulder, 1956. 197-202 (Published 1957). Chem. Abstr. 52 19034 (1958).

Activated charcoal at -196°C will remove helium and ca 35% of the nitrogen from neon. The apparatus used is described. The neon may be purified further by chemical means.

1050. Gas Chromatography: An Automatic Instrument for Hazardous Areas.

PARKS, M. L.

Oil Gas J. 54 (85) 136, 138, 140 (1956).

Description of an apparatus in which the analyser is housed in an explosion proof container.

1051. A Method of Recording Chromatographic Readings.

PATERNO, F. E., UGOLINI, F. and CHAIN, E. B.

Ital. 546,831 (1956). *Chem. Abstr.* 52 9684 (1958).

A description of an apparatus in which chromatographic readings are reproduced in a printed form.

1052. Use of Adsorbents in Vapour-Phase Chromatography.

PATTON, H. W.

Presented at 129th National A.C.S. Meeting, Dallas, Texas, April 1956. Abstracts p. 14B No. 37.

A review of the use of adsorbents, with a discussion of the principles of elution and displacement development. Typical applications are described briefly, and it is expected that in the future the scope of adsorbents may be considerably enlarged by pretreatment with small amounts of other substances.

1053. Gas Chromatography.

PATTON, H. W.

Presented at 10th Ann. Symposium on Modern Methods of Anal. Chem., Baton Rouge, January 1957. Abstract in Anal. Chem. **29** (2) 313 (1957).

The principles of gas chromatography were reviewed, and methods of elution, displacement and frontal analysis discussed. Adsorption and partition methods were described and illustrated, the advantages and disadvantages of each being outlined. The efficiency of separation was also considered in relation to the selectivity of the column packing. Some applications were outlined.

1054. Fractionation and Analysis on a Micro Scale by Gas Chromatography.

PATTON, H. W. and LEWIS, J. S.

Presented at 3rd National Air Pollution Symposium, Pasadena, April 1955. Abstract in Anal. Chem. **27** (6) 1034 (1955).

Described the analysis of automobile exhaust gases, and reported that several light hydrocarbons were detected using a thermal conductivity detector. The same detector was also used to establish the minimum concentrations of some substances present in 'smog' which could be detected using this method.

1055. Gas Chromatographic Determination of Some Hydrocarbons in Cigarette Smoke.

PATTON, H. W. and TOUEY, G. P.

Anal. Chem. **28** (11) 1685-1688 (1956). *Chem. Abstr.* **51** 3094 (1957).

Seven hydrocarbons present in cigarette smoke were separated on a column (130 cm $\times$ 0.55 cm) of silica gel at $25 \pm 2^\circ\text{C}$, using helium as carrier gas and thermal conductivity detection.

1056. Separation and Analysis of Gases and Volatile Liquids by Gas Chromatography.

PATTON, H. W., LEWIS, J. S. and KAYE, W. I.

Anal. Chem. **27** (2) 170-174 (1955). *Chem. Abstr.* **49** 9910 (1955).

The methods described involved elution by hydrogen, nitrogen or carbon dioxide from columns of charcoal, silica gel or alumina, and were used to separate hydrocarbons boiling below 150°C . A modified thermal conductivity cell was used as a detector.

1057. Gas-Liquid Partition Chromatography.

PATTON, H. W., LEWIS, J. S. and KAYE, W. I.

J. Tenn. Acad. Sci. **32** 185 (1957).

A description of the principles, apparatus and applications of gas-liquid partition chromatography, with 29 references.

1058. Chemical Aspects of Flavour Research on Milk and its Products.

PATTON, S.

Perfumery Essent. Oil Record **49** 386-390 (1958). *Chem. Abstr.* **52** 18940 (1958).

A chromatogram of volatile material from skim milk shows acetaldehyde, methyl sulphide, acetone, butanone, methanol and ethanol in that order from a 'Carbowax' column.

1059. Quantitative Analysis of 'Freon' Fluorinated Hydrocarbons by Vapour-Phase Chromatography.

PERCIVAL, W. C.

Presented at Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, February 1956.

Mixtures containing CCl_2F_2 , CCl_3F and $\text{CClF}_2\text{-CClF}_2$ can be analysed

with an accuracy of $\pm 0.5\%$, and a concentration of 0.01% of any of these compounds in air is detectable. The paper also discussed the effects of several variables in the vapour-phase chromatographic method. See also the next reference.

1060. Quantitative Determination of Fluorinated Hydrocarbons by Gas Chromatography.

PERCIVAL, W. C.

Anal. Chem. **29** (1) 20-24 (1957). *Chem. Abstr.* **51** 11939 (1957).

Several commercial mixtures of Freon compounds have been analysed by gas chromatography on a column (160 cm $\times$ 5 mm) of Celite 545 impregnated with dioctyl phthalate at 56°C (Freon 11 and 12), or on a similar column of alumina (Freon 11 and 114). Hydrogen is used as carrier gas in both cases. The operating variables discussed included eluting pressure, cell current and temperature, column temperature and length of adsorbent packing.

1061. Adsorption and Desorption.

PETERS, K.

Reichsanst. Wirtschftsabau, Pruf.-Nr. **43** 113-120 (1940). *Chem. Abstr.* **41** 6105 (1947).

The separation and purification of gases is reviewed from both the theoretical and practical aspects of adsorption and desorption. The use of activated charcoal to separate argon, krypton and xenon is described.

1062. Peak Area vs Peak Height in Quantitative Gas Chromatography.

PETITJEAN, D. L.

Presented at Conf. on Anal. Chem. Pittsburgh, March 1958. Paper 146.

No further details are available.

1063. New Direct Method of Calibration for Gas Chromatography.

PETITJEAN, D. L.

Presented at Conf. on Anal. Chem. Pittsburgh, March 1958. Paper 147.

No further details are available.

1064. Partition Chromatography in the Vapour-Phase.

PEYROT, P.

Ind. Parfum. **11** 424-434 (1956).

A description of the method and its applications to quantitative and qualitative analysis. Curves are shown for Cyclamon (cyclamol and dehydrocyclamol are clearly separated and quantitatively determined), geranium Bourbon oil, rhodinol rhodia, citronella oil, geraniol, synthetic and natural Rose oil, (which are distinctly different), and a mixture of linalol and benzyl and phenylethyl alcohol on 2 different instruments.

1065. Use of Vapour-Phase Chromatography for Rapid Analysis of Mixtures of Solvent.

PEYROT, P.

Chim. & ind. (Paris) **78** 3-8 (1957). *Chem. Abstr.* **52** 153 (1958).

The paper contains a discussion on the choice of suitable stationary phases, and describes the separation of a mixture of ethanol, methanol, methyl formate, ethyl formate, methyl acetate and acetone on columns of penta-chlorobiphenyl on Celite 545, and a silicone oil, (Rhodorsil 47V300) on Celite 545.

- 1066.** Gas Chromatography. The Chromatography of Gases and Vapours.
PHILLIPS, C. S. G.

Discussions Faraday Soc. 1949, No. 7 241-248. *Chem. Abstr.* **45** 1460 (1951).

A simple self recording apparatus is described for the analysis of gas and vapour mixtures by displacement from an adsorbent. The influence of factors such as particle size, flow-rate, column design, type of adsorbent, temperature and nature of the mixture upon the accuracy of the analysis is discussed. Illustrations are given of the application of the method.

- 1067.** Adsorption and Partition Methods.

PHILLIPS, C. S. G.

Presented at Symposium on Gas Chromatography, Stevenston, Scotland, May 1955. Abstract in Anal. Chem. **27** (10) 1667 (1955).

The use of glass thermal conductivity cells and the surface potential detector was discussed, and a comparison was given of the displacement and elution methods of adsorption gas chromatography.

- 1068.** Gas Chromatography.

PHILLIPS, C.

Published by Butterworths 1956. 98 pp.

A broad survey of the subject, including history and comparison with other methods, theoretical principles, general apparatus, vapour detectors, qualitative and quantitative analysis, and a comparison of adsorption and partition methods. 81 references are given. This book was also published in the U.S.A. by the Academic Press Inc., New York, in 1956.

- 1069.** Gas Chromatography.

PHILLIPS, C. S. G.

An article in 'Physical Methods in Chemical Analysis'.

Ed. BERL, W. G. Vol. III. pp. 1-28. Published by Academic Press 1956. (Also listed under BERL, W. G. See reference 162.)

A general description of the theory of gas chromatography, the apparatus used, column packings and detectors. Both partition and adsorption columns are described and examples of some separations are given (aliphatic amines, alcohols, hydrocarbons, etc.). Both qualitative and quantitative applications are discussed and a comparison with other analytical techniques is included.

- 1070.** Gas Chromatography.

PHILLIPS, C. S. G.

Discovery **18** (11) 472 (1957).

A general descriptive article.

- 1071.** Gas Chromatography.

PHILLIPS, C. S. G.

Nature **180** (4591) 840-841 (1957).

An account of the International Symposium on Gas Chromatography held at the Kellogg Centre for Continuing Education, East Lansing, Michigan, in August 1957, with short abstracts of some of the papers presented. All the papers described have been published and are reported elsewhere.

- 1072.** Gas-Liquid Chromatography.

PHILLIPS, C. S. G.

Svensk. Kem. Tidskr. **69** 199-212 (1957). *Chem. Abstr.* **51** 11809 (1957).

A review of the subject giving 19 references.

1073. Gas Chromatography Instrumentation for the Laboratory.

PHILLIPS, C. S. G.

Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.

Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 51-63. Discussion 64-65.

This article discusses processes taking place inside a chromatographic column, and a consideration of the chromatogram peaks in terms of the retention time of the peak maximum and the spread of the peak. Theoretical plates, retention times, separation, variation of the column liquid, and the use of metal salts as column liquids are among the subjects specifically discussed.

1074. An Electronic Method of Detecting Impurities in Air.

PHILLIPS, G.

J. Sci. Instr. **28** 342-347 (1951). *Chem. Abstr.* **46** 3330 (1952).

A description of a device which measures the changes in surface potential of specially prepared plates. These changes give an indication of the impurities present in an air stream.

1075. Continuous Separation of Gases by a New Process of Countercurrent Distribution.

PICHLER, H. and SCHULZ, H.

Brennstoff-Chem. **39** 148-153 (1958). *Chem. Abstr.* **52** 12510 (1958).

A discussion showing the development of the principle of continuous gas chromatography which is particularly suited to the separation of related materials. The discussion is illustrated by the separation of butane from *trans*-2-butene and of *cis*-butene from *trans*-butene.

1076. Solvent Effects in Gas-Liquid Partition Chromatography.

PIEROTTI, G. J., DEAL, C. H., DERR, E. L. and PORTER, P. E.

J. Am. Chem. Soc. **78** (13) 2989-2998 (1956). *Chem. Abstr.* **50** 14311 (1956).

The conclusions drawn from the work described in this paper were that (a) within a homologous series of solutes, at a given temperature, the log ratio of the partition coefficients in solvents may be expected to be a linear function of the solute carbon atom number, and also that (b) over the restricted ranges in carbon atom numbers which are of interest in a gas-liquid partition chromatographic separation, the log of the partition coefficients for members of the series may be expected to be linear in carbon number.

1077. Determination of Very Small Amounts of Oxygen, Carbon Monoxide, Methane and Nitrogen in Purest Ethylene by Adsorption Chromatography.

PIETSCH, H.

Erdol u Kohle **11** (3) 157-159 (1958). *Chem. Abstr.* **52** 10800 (1958).

A good separation of these compounds was obtained on molecular sieve 5A, but silica gel and molecular sieve 4A did not give a good separation.

1078. Gas-Liquid Chromatography.

PILPEL, N.

Paint Technology **19** (218) 380 (1955).

A general descriptive article which gives details of detection methods and quantitative determinations. A thermal conductivity cell is described and illustrated.

1079. Base-Catalysed Reactions. XIII. The Relative Rates of Side-Chain Ethylation of Aromatic Hydrocarbons.

PINES, H. and SCHAAP, L.

J. Am. Chem. Soc. **80** (12) 3076-3079 (1958). *Chem. Abstr.* **52** 19984 (1958).

The reaction products were separated on a 6 ft or 12 ft column packed with either tricresyl phosphate on Celite or paraffin wax on firebrick. Nitrogen was used as carrier gas in both cases.

1080. Low Pressure Electric Discharge Detectors.

PITKETHLY, R. C.

Advances in Gas Chromatography—A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D-67 to D-76. (Presented during 132nd Meeting, A.C.S.)

Low pressure electric discharge tubes can be used as sensitive and robust vapour detectors in gas chromatography and a stable detector can be made from a modified neon lamp. Full details of suitable techniques, and the factors influencing the design and operation of discharge tubes are given. See the following reference.

1081. Low Pressure Electric Discharge Detectors.

PITKETHLY, R. C.

Anal. Chem. **30** (8) 1309-1314 (1958). *Chem. Abstr.* **52** 16802 (1958).

Using modified neon lamps as detectors, the paraffin hydrocarbons were readily detected at concentrations of 1 in 10^7 . The detector is simple and gave a high output level and good sensitivity.

1082. Device for Development of Chromatograms with (Gaseous) Toxic Substances.

PLATEK, J.

Roczniki Chem. **31** 685-686 (1957). *Chem. Abstr.* **52** 2463 (1958).

Only the title is listed in *Chem. Abstr.*

1083. Speedy, Accurate Hydrocarbon Analysis.

PODBIELNIAK, W. J. and PRESTON, S. T.

Petroleum Engr. **27** (5) C17-C25 (1955). *Chem. Abstr.* **49** 9909 (1955).

Gives a description of new developments in low-temperature fractional distillation.

1084. New Tool—Vapour-Phase Chromatography.

PODBIELNIAK, W. J. and PRESTON, S. T.

Petroleum Refiner **34** (11) 165-169 (1955). *Chem. Abstr.* **50** 559 (1956).

A review which deals with the history of chromatography, and the 3 general techniques of frontal analysis, displacement analysis and elution analysis. It includes a description of apparatus, techniques, applications, and correlation with other analytical methods. 42 references are given.

1085. Vapour-Phase Chromatographic Equipment—Developments in Light Hydrocarbon Analysis.

PODBIELNIAK, W. J. and PRESTON, S. T.

Oil Gas J. **54** (50) 211-212, 215-216, 219 (1956). *Chem. Abstr.* **51** 4773 (1957).

Describes a new thermal conductivity cell for low temperature distillation equipment, and also the 'Chromacon' for vapour-phase chromatography. Hydrocarbons including olefins and aromatics can be separated, and also natural gases, liquefied petroleum gases and natural gasolines.

1086. Gas Chromatography: What of the Future?

PODBIELNIAK, W. J. and PRESTON, S. T.

Presented at 31st Ann. Meeting, California Nat. Gas Assoc., Los Angeles, November 1956. Reported in Oil Gas J. 54 (85) 140 (1956).

A brief description of the present status of gas chromatography, with a forecast that in future it will be used for the continuous monitoring of process streams, and that larger columns can probably be used with advantage, especially for the preparative scale separation of pure compounds.

1087. Vapour-Phase Chromatography.

PODBIELNIAK, W. J. and PRESTON, S. T.

Petroleum Refiner 35 (4) 215-220 (1956). Chem. Abstr. 50 8368 (1956).

Approximate retention times are given for alcohols, ketones, esters, fatty acids, liquid hydrocarbons, and nonhydrocarbon gases on various stationary phases.

1088. The Future Possibilities of Gas Chromatography.

PODBIELNIAK, W. J. and PRESTON, S. T.

Gas 34 (2) 119-120, 122, 126 (1958). Chem. Abstr. 52 4383 (1958).

A review of the successful applications of gas chromatography to hydrocarbons and petroleum fractions. Investigations are in progress to increase detector sensitivity and column efficiency.

1089. Analysis of Fatty Acids and their Esters by Vapour-Phase Chromatography.

PODBIELNIAK, W. J., PRESTON, S. T. and TURKAL, P. J.

Presented at 30th Fall Meeting of Am. Oil Chemists Soc., Chicago, September 1956. Abstract in Anal. Chem. 28 (12) 2027 (1956).

The principles of the method were described, and the equipment necessary for carrying it out was explained. Methods of analysis of fatty acids and their esters were reviewed.

1090. Gas-Liquid Chromatography of Liquid Hydrocarbons from Mineral Oil.

PODKLETNOV, N. E. and BRYANSKAYA, E. K.

Uspekhi Khim. 27 1354-1360 (1958). Chem. Abstr. 53 4707 (1959).

The paper consists largely of a table listing columns, conditions, etc. for separating and identifying the hydrocarbons. There are a few notes on detection techniques. The paper is essentially a review of developments in this field during 1957, and 100 references are given.

1091. Radiolysis of Heptane and some other Alkanes.

POLAK, L. S., TOPCHIEV, A. V. and CHERNIAK, N. Y.

Doklady Akad. Nauk. S.S.S.R. 119 (2) 307-310 (1958). Chem. Abstr. 53 194 (1959).

Hydrogen, methane and other hydrocarbons in the reaction products were separated by gas chromatography on columns of charcoal and silica gel.

1092. Gas Chromatography.

POLLARD, F. H.

Presented at British Assoc. Meeting (Section B) Bristol, September 1955. Reported in Nature 176 1188-1190 (1955).

A general review of gas-solid and gas-liquid chromatography, with practical demonstrations of thermal conductivity and density balance detectors.

- 1093.** The Effect of Temperature of Injection Upon the Separation of Liquid Mixtures by Gas-Phase Chromatography.

POLLARD, F. H. and HARDY, C. J.

Chem. and Ind. (London) 1955 (37) 1145-1146. *Anal. Abstr.* **3** 636 (1956). The temperature of injection was studied on columns (80 cm $\times$ 4 mm) of kieselguhr impregnated with dinonyl phthalate, operated at 40°C. The effect of this temperature on peak height and theoretical plate number is reported for a mixture of acetone, chloroform and carbon tetrachloride.

- 1094.** The Application of Vapour-Phase Chromatography to the Preparation of Pure Materials.

POLLARD, F. H. and HARDY, C. J.

Chem. and Ind. (London) 1956 (23) 527-528. *Chem. Abstr.* **50** 16530 (1956). A column of Celite 545 impregnated with dinonyl phthalate was used to purify ethyl nitrate which contained ethanol and traces of methanol. Small amounts of formic acid free from water were also prepared.

- 1095.** The Analysis of Halogenated Hydrocarbons by Vapour-Phase Chromatography.

POLLARD, F. H. and HARDY, C. J.

Anal. Chim. Acta **16** (2) 135-143 (1957). *Chem. Abstr.* **51** 7239 (1957).

The separation of halogenated hydrocarbons is described. Various stationary phases were used and included dibutyl phthalate, dinonyl phthalate and Silicone 702. The data are presented as plots of the log of the corrected retention volume per gram of stationary phase against the inverse of the column temperature.

- 1096.** A Preliminary Study of some Factors Influencing the Order of Elution of Halogenated Methanes, the Degree of Separation and the Reproducibility of Retention Volumes in Gas-Liquid Partition Chromatography.

POLLARD, F. H. and HARDY, C. J.

I.P. Symposium, London, 1956. 115-126.

Ed. DESTY, D. H. Published by Butterworths 1957.

The order of elution of a series of halogenated methanes has been shown to depend upon the nature of the liquid phase, and in the case of water as a liquid phase, upon the amount present. These compounds are eluted in order of their boiling point upon columns containing liquid paraffin and Silicone 702, but partial or complete inversion of this order is obtained on columns containing dibutyl phthalate, dinitrophenol, glycerol, and water.

- 1097.** Effect of Nitrogen Dioxide on the Thermal Decomposition of Ethyl Nitrite.

POLLARD, F. H., PEDLER, A. E. and HARDY, C. J.

Nature **174** 979 (1954). *Chem. Abstr.* **49** 5085 (1955).

The products of reaction, which contained ethyl nitrite, ethyl nitrate and water, were separated on a column of kieselguhr impregnated with dibutyl phthalate. Nitrogen was used as carrier gas.

- 1098.** Charcoal Chromatography with a Step-Graded Adsorption Column.

PORATH, J.

Arkiv. Kemi. **7** (6) 535-537 (1954). *Chem. Abstr.* **49** 7437 (1955).

In English. Describes the construction of a sectional column of charcoal in which each section contains charcoal impregnated to a different degree of saturation with stearic acid. This causes the adsorptive power of the column to fall by discrete stages down its length, and has the advantage

that components of widely differing adsorbability may be separated on the same column.

1099. The Determination of Partition Coefficients from Gas-Liquid Partition Chromatography.

PORTER, P. E., DEAL, C. H. and STROSS, F. H.

J. Am. Chem. Soc. **78** (13) 2999-3006 (1956). *Chem. Abstr.* **50** 14312 (1956).

It is shown experimentally that the partition coefficients obtained are essentially sound equilibrium partition coefficients, and it is thus concluded that these coefficients rather than retention volumes are the best parameters for use in gas-liquid partition chromatography. The partition coefficients of some hydrocarbons and alcohols are given at various temperatures, using diisodecyl phthalate as stationary phase.

1100. Gas Chromatography Determination of Fuel Dilution in Lubricating Oils.

PORTER, R. S. and JOHNSON, J. F.

Presented at Division of Petroleum Chemistry, A.C.S. Meeting, Chicago, September 1958. A.C.S. General Papers of Division of Petroleum Chemistry **3** (3) 157-163 (1958).

With the aid of a simple attachment to a conventional gas chromatography apparatus, a method for determining fuel dilution has been developed which has good precision, accuracy and sensitivity. The method requires the use of an internal standard.

1101. Modern Trends in Petroleum Analysis.

POWELL, H. and THOMAS, W. H.

J. Inst. Petrol. **44** 19-28 (1958). *Chem. Abstr.* **52** 7671 (1958).

The methods of analysis used are reviewed critically, and 52 references are included. These methods include those for chromatography.

1102. Sorting Molecules by Shape and Size.

POWELL, H. M.

Presented at British Assoc. Meeting (Section B) Bristol, September 1955. Reported in Nature **176** 1188-1190 (1955).

A description of the structure of molecules in relation to their ability to separate different compounds. The talk was illustrated by examples.

1103. Vapour Chromatography and its Application to Pharmacy.

POY, F.

Boll. Chim. farm. **96** 553-555 (1957). *Chem. Abstr.* **52** 5745 (1958).

A general descriptive article.

1104. Gas Chromatography.

PRETORIUS, V.

S. African Ind. Chemist **10** 303-308 (1956). *Chem. Abstr.* **51** 5501 (1957).

A review which includes 28 references.

1105. *Analysis of Light Hydrocarbon Mixtures by Gas Chromatography.

PRICE, A. R.

Presented at 3rd Ann. Tech. Meeting of Saline Area Section, A.I.Ch.E. and Texas-Louisiana Gulf Section, A.C.S. Beaumont, Texas, March 1956.

Described the separation of methane, ethane and propane on a column (12ft $\times$ $\frac{3}{8}$ in.) of firebrick impregnated with kerosene, using helium as carrier gas with thermal conductivity detection.

- 1106. Metal-Carbon Bonds. I. The Pyrolysis of Dimethyl Mercury and Dimethyl Cadmium.**
PRICE, S. J. W. and TROTMAN-DICKENSON, A. F.
Trans. Faraday Soc. **53** 939-944 (1957). *Chem. Abstr.* **52** 9950 (1958).
Analysis of the dimethyl mercury showed a maximum of 0.1% impurity. The ethylene content of the ethane reaction products was determined by gas chromatography.
- 1107. Heat Conductivity and Chemical Reactions in Gases.**
PRIGOGINE, I. and WOELBROCK, F.
Brit. Chem. Eng. **2** 596 (1957). *Chem. Abstr.* **52** 4302 (1958).
A method is described for measuring the thermal conductivities of various gases.
- 1108. A Study of the Hydrogen Flame Detector using Nitrogen as Carrier Gas.**
PRIMAVESI, G. R., OLDHAM, G. F. and THOMPSON, R. J.
Gas Chromatography 1958. Amsterdam Symposium—May 1958.
Ed. DESTY, D. H. Published by Butterworths 1958. 165-174. Discussion 175-177.
This paper describes investigations into the shape of the flame and the response of the detector and noise at various heights above the jet. Some measurements have also been made on the effect on the baseline of small variations in nitrogen and air flow and the effect of atmospheric pressure changes.
- 1109. Modified Thermal Conductivity Gas Analyser for Measuring Methane in Air or Carbon Dioxide.**
PRITCHARD, F. W.
J. Sci. Instr. **29** 116-117 (1952). *Chem. Abstr.* **46** 5898 (1952).
By using convective instead of conductive heat transfer, the described instrument can in some cases be made insensitive to a third gas component. Methane has been measured in mixtures of nitrogen/carbon dioxide/oxygen, and carbon dioxide in air/methane, air/water vapour and air/hydrogen mixtures.
- 1110. A New Technique of Gas Sampling.**
PRITCHARD, F. W. and WALTON, W. H.
Chem. and Ind. (London) 1952 166-167. *Chem. Abstr.* **46** 8565 (1952).
After compression of the gas sample, it may be delivered to the analysis apparatus at low pressures by means of a pressure regulator.
- 1111. New Developments in Instrumental Analysis.**
PUNGOR, E.
Magyar Kem. Lapja **13** 101-107 (1958). *Chem. Abstr.* **52** 13518 (1958).
A review of instrumental analysis giving 192 references.
- 1112. Unique Thermal Conductivity Gas Analyser.**
PURCELL, J. R., DRAPER, J. W. and WEITZEL, D. H.
Proc. Cryogenic Eng. Conf. 2nd, Boulder, 1956. 191-195. (Published 1957.)
Chem. Abstr. **52** 13325 (1958).
This bridge type gas analyser uses an exciting current of 60-cycle a.c. which improves its sensitivity.
- 1113. A Basis for the Comparison and Choice of Solvents in Vapour-Phase Partition Chromatography.**
PURNELL, J. H.
I.P. Symposium, London, 1956. 52-62.
Ed. DESTY, D. H. Published by Butterworths 1957.

The general applicability of the log relation between the retention volume and the saturation vapour pressure of a solute at the elution temperature is demonstrated and 3 new examples of the 'family' plot are given. The usefulness of the $\log v' / \log p$ and inverse temperature dependence plots in the quantitative comparison and choice of solvent and of experimental conditions is discussed, and examples of their use for this purpose are given.

1114. Physics in the Service of Chemistry. Gas Chromatography.

PURNELL, J. H.

J. Roy. Inst. Chem. **82** 586-608 (1958). *Chem. Abstr.* **52** 19269 (1958).

A general descriptive article which covers apparatus, theory, thermodynamics and applications. There are 12 figures to illustrate the text and 40 references are appended.

1115. Use of Solubilising Agents in Gas-Phase Partition Chromatography.

PURNELL, J. H. and SPENCER, M. S.

Nature **175** 988-989 (1955). *Chem. Abstr.* **49** 12175 (1955).

Column efficiency and rapidity of elution in gas-phase partition chromatography can be improved by modifying the stationary solvent to give increased solubility and greater differential elution. In the elution of chloromethanes with nitrogen on 38 cm columns of kieselguhr at 20°C, the use of a mixture of Teepol and water (3 + 2 by wt) as solvent ensures a large increase in retention volume, elution occurring in order of increasing chlorine content of the molecule. Since water alone is ineffective, the improvement is ascribed to enhanced solubility in the mixed solvent. Addition of 17.5% w/w stearic acid to a 12 cm column of liquid paraffin—kieselguhr will effectively separate the chloromethanes in *ca* 15 min by elution with nitrogen.

1116. Separation of some Tobacco Alkaloids by Gas Chromatography.

QUIN, L. D.

Nature **182** (4639) 865 (1958). *Chem. Abstr.* **53** 5596 (1959).

Three columns were used in this work. The inert support was firebrick in each case, and the stationary phases were polyethylene glycol at 190°C, polypropylene glycol at 190°C, and polybutylene glycol at 180°C. The carrier gas was helium. The article also gives a table of the retention times on the 3 columns for various alkaloids.

1117. Analysis of the Nonvolatile Acids in Cigarette Smoke by Gas Chromatography of Their Methyl Esters.

QUIN, L. D. and HOBBS, M. E.

Anal. Chem. **30** (8) 1400-1405 (1958). *Chem. Abstr.* **52** 17623 (1958).

The acids were converted to their methyl esters by reaction with diazomethane, and separated on a column of firebrick (or Celite 545) impregnated with dioctyl adipate. Helium was used as carrier gas.

1118. Determination of Trace Quantities of Hydrocarbons in the Atmosphere.

QUIRAM, E. R. and BILLER, W. F.

Anal. Chem. **30** (7) 1166-1171 (1958). *Chem. Abstr.* **52** 16662 (1958).

The method described is a freeze-out method in which oxygen, nitrogen and hydrogen are pumped off from the sample at liquid nitrogen temperature, but the hydrocarbon gases remain. The hydrocarbons are identified by mass spectrometry.

1119. Simple Greaseless Valves.

RAATS, E., HARLEY, J. and PRETORIUS, V.

J. Sci. Instr. **34** (12) 510 (1957).

The design, construction and operation of these valves is fully described.

1120. Approximate Calculation of Molecular Chromatograms.

RACHINSKII, V. V.

Doklady Akad. Nauk. S.S.S.R. **88** 883-886 (1953). *Chem. Abstr.* **47** 11882 (1953).

The cases in which one or two substances are adsorbed on a column are considered in relation to the theory of molecular chromatograms which is applicable to both adsorption and distribution chromatograms.

1121. Selection of a Stationary Phase for Qualitative Gas Chromatographic Analysis.

RAUPP, G.

Presented at Meeting on 'The Analysis of Gaseous and Liquid Hydrocarbons and their Derivatives by Physical Methods'. Essen. January 1958. Printed in Z. anal. Chem. **164** (1) 135-146 (1958).

In German. Relative retention volumes over a range of temperatures are reported for 120 substances including hydrocarbons, alcohols, esters, ethers, ketones, acids, aldehydes, etc. on columns of di-*n*-decylphthalate, di-ethyl-hexylsebecate, silicone oil DC 200, tetraethylene glycoldimethyl ether, Fluorene/picric acid and polyethylene glycol.

1122. Gas Chromatography. I. The Separation and Estimation of Volatile Organic Compounds by Gas-Liquid Partition Chromatography.

RAY, N. H.

J. Appl. Chem. (London) **4** (1) 21-25 (1954). *Chem. Abstr.* **49** 2257 (1955).

The work described is an extension of that carried out by James and Martin. Mixtures of hydrocarbons, alcohols, esters, ethers, aldehydes and ketones were separated on columns of kieselguhr impregnated with di(3,5,5-trimethylhexyl) phthalate, using thermal conductivity detection.

1123. Gas Chromatography. II. The Separation and Analysis of Gas Mixtures by Chromatographic Methods.

RAY, N. H.

J. Appl. Chem. (London) **4** (2) 82-85 (1954). *Chem. Abstr.* **48** 11244 (1954).

Describes an elution development method of gas chromatographic analysis. The lighter gases such as hydrogen, carbon monoxide, methane, ethane, ethylene and acetylene were separated on a column of activated charcoal, and heavier gases such as propane, propylene and the C₄ hydrocarbons were separated on a partition column of dinonyl phthalate.

1124. Rapid Chromatographic Method for Determination of Bromine-Inert Impurities in Ethylene.

RAY, N. H.

Presented at Symposium on Gas Chromatography, Stevenston, Scotland, May 1955. Abstract in Anal. Chem. **27** (10) 1667 (1955).

See the following reference.

1125. A Rapid Chromatographic Method for the Determination of Impurities in Ethylene.

RAY, N. H.

Analyst **80** (957) 853-860 (1955). *Chem. Abstr.* **50** 4714 (1956).

The determination of small amounts of non-olefinic impurities (except carbon dioxide) in ethylene is described. Ethylene is absorbed on bromine-impregnated charcoal, and the remaining impurities are analysed by elution from activated charcoal in a current of carbon dioxide. The fractions are collected and measured in a nitrometer over potassium hydroxide solution.

1126. Gas Chromatography.

RAY, N. H.

Presented at Meeting of Birmingham and Midland Section of S.C.I. with R.I.C. December 1955. Reported in Chem. and Ind. (London) 1956 (3) 75.

A general review of both gas-solid and gas-liquid chromatography.

1127. Gas Chromatography.

RAY, N. H.

Chem. Trade J. **141** (3667) 630 (1957).

A short general descriptive article.

1128. Gas Chromatography.

RAY, N. H.

Nature **180** (4583) 403-405 (1957).

A general review article with 20 references, dealing with adsorption columns, partition columns and detectors.

1129. Effect of the Carrier Gas on the Sensitivity of a Thermal Conductivity Detector in Gas Chromatography.

RAY, N. H.

Nature **182** (4650) 1663 (1958). *Chem. Abstr.* **53** 9738 (1959).

The sensitivity of the detector is inversely proportional to the square of the thermal conductivity of the carrier gas, and directly proportional to the difference in thermal conductivity. It follows that the carrier gas with the lowest thermal conductivity will give the highest sensitivity. This was confirmed experimentally using mixtures of methane, ethane and propane with carrier gases helium and argon.

1130. Addition Compounds of Thiourea.

REDLICH, O., GABLE, C. M., BEASON, L. R. and MILLAR, R. W.

J. Am. Chem. Soc. **72** (9) 4161-4162 (1950). *Chem. Abstr.* **45** 1850 (1951).

The composition and the equilibrium constants for the decomposition of the thiourea complexes of 5 isoparaffins, 5 naphthenes and carbon tetrachloride have been determined.

1131. Addition Compounds of Urea and Organic Substances.

REDLICH, O., GABLE, C. M., DUNLOP, A. K. and MILLAR, R. W.

J. Am. Chem. Soc. **72** (9) 4153-4160 (1950). *Chem. Abstr.* **45** 3807 (1951).

Data are presented for urea complexes of *n*-paraffins, *n*-olefins, halides, alcohols, ketones, acids and methyl esters, an ether and dioxane. The data furnish a complete description of the *n*-paraffin complexes between C₇ and C₁₆. Data for a large field of derivatives can be estimated by systematic comparison of the results presented.

1132. A Simple and Inexpensive Emission Regulator for Ionisation Gauges.

REECE, M. P.

J. Sci. Instr. **34** (12) 513 (1957).

A full description is given and a wiring diagram is included.

1133. Gas-Liquid Partition Chromatography of Fluorocarbons.

REED, T. M.

Anal. Chem. **30** (2) 221-228 (1958). *Chem. Abstr.* **52** 6892 (1958).

The separation of fluorocarbons was compared on various stationary phases using nitrogen as carrier gas at various flow rates. Stationary phases for which results are reported were di(2-ethylhexyl) sebacate, hexadecane, the

ethyl ester of Kel-F acid 8114, Kel-F 90 grease, perfluorokerosine and perfluorotributylamine.

- 1134.** Crystalline Zeolites. II. Crystal Structure of Synthetic Zeolite, Type A. REED, T. B. and BRECK, D. W.

J. Am. Chem. Soc. **78** (23) 5972-5977 (1956). *Chem. Abstr.* **51** 5498 (1957). The crystal structure is evaluated, described and discussed. Probable positions of the cations in the Li, Na, Tl and Ca forms are indicated and correlation of the structure with the adsorptive and ion-exchange properties of the zeolite is discussed.

- 1135.** Progress in Process Instrumentation. 'REGULUS.'

Ind. Chemist **33** (392) 520-522 (1957).

A general description of gas chromatography for process analysis.

- 1136.** Nitrogen Purification. Pilot-Plant Removal of Oxygen.

REICH, M. and KAPENEKAS, H.

Ind. Eng. Chem. **49** (5) 869-873 (1957). *Chem. Abstr.* **51** 17115 (1957).

A sodium dithionate scrubbing solution containing sodium phosphate and zinc sulphate was used to purify nitrogen. The final product contained less than 0.03% oxygen.

- 1137.** Effect of Molecular Properties on Gas-Phase Mass-Transfer Coefficients. REID, L. J.

Univ. Microfilms Publ. No. 23278, 217 pp. *Dissertation Abstr.* **17** 2541 (1957). *Chem. Abstr.* **52** 2467 (1958).

Only the title is listed in *Chem. Abstr.*

- 1138.** Sampling Method for Analysis of Coffee Volatiles by Gas Chromatography.

RHOADES, J. W.

Food Research **23** 254-261 (1958). *Chem. Abstr.* **52** 20761 (1958).

The sampling technique is described. Volatile materials are swept from the coffee with a stream of warm moist helium, and separated from water and carbon dioxide by condensation before entering the gas chromatographic column. A typical chromatogram is given. Copper and stainless steel columns gave identical results, and no correlation with aroma has been found.

- 1139.** A Simple Phase Sensitive Rectifier for Use with Radiation Detectors. RICHARDS, J. C. S.

J. Sci. Instr. **35** (8) 285-286 (1958).

Describes the use of 2 cadmium selenide photocells in an arrangement which makes a coherent demodulator. This has the advantages of a mechanical rectifier but not the usual disadvantages.

- 1140.** Labelling of some C₆ Hydrocarbons by Exposure to Tritium.

REISZ, P. and WILZBACH, K. E.

Presented at 132nd Meeting, A.C.S., New York, September 1957. Abstr. p. 14R No. 52.

See the following reference.

- 1141.** Labelling of some C₆ Hydrocarbons by Exposure to Tritium.

RIESZ, P. and WILZBACH, K. E.

J. Phys. Chem. **62** (1) 6-9 (1958). *Chem. Abstr.* **52** 7895 (1958).

Gas chromatography was used to analyse the products after reaction of tritium with *n*-hexane, cyclohexane and benzene. Non-polymeric irradiation products were examined on a Perkin-Elmer 154 Fractometer, modified by the addition of a small ionisation chamber in series with a thermal conductivity cell. Chemical and radiochemical peaks were registered simultaneously on synchronised recorders.

1142. Separation of Fatty Acids of Various Molecular Weights by Means of Urea Addition Compounds.

RIGAMONTI, R. and RICCIO, V.

Ann. chim. (Rome) **44** (3-4) 288-298 (1954). *Chem. Abstr.* **49** 5003 (1955).

The acids in a mixture of natural fatty acids dissolved in benzene were separated by fractional precipitation from a saturated aqueous solution as double compounds with urea, and under appropriate conditions, obtained with a purity of 90%.

1143. The Chromatographic Method for the Study of Essential Oils and their Components.

RIGANESIS, M. D.

Essenze deriv. agrumari **26** (1) 29-61 (1956). *Chem. Abstr.* **50** 15027 (1956).

A review of the applications of chromatography with 237 references, 17 of which refer to gas chromatography.

1144. Analysis of Hop Oil by Gas-Liquid Partition Chromatography.

RIGBY, F. L. and BETHUNE, J. L.

J. Inst. Brewing **63** (2) 154-161 (1957). *Anal. Abstr.* **4** 3128 (1957).

The article describes a laboratory-made apparatus which may be used at temperatures up to 200°C. The column used for whole oils was Celite impregnated with Dow Corning high-vacuum silicone stopcock grease, and that used for oxygenated fractions was firebrick impregnated with Apiezon M grease. In both cases hydrogen was used as carrier gas with thermal conductivity detection.

1145. Gas-Liquid Chromatography Analysis of Amine Mixtures.

RING, R. D. and RILEY, F. W.

Presented at 6th Ann. Anachem. Conf., Detroit, October 1958.

No further details are available.

1146. High Speed Electronic Integrator.

RITZENTHALER, B. A.

Presented at 6th Ann. Anachem. Conf., Detroit, October 1958.

No further details are available.

1147. The Effect of the Ratio of Partition Liquid to Inert Support on the Separation of (1) Mono-, Di- and Triethylene Glycols and (2) *Cis*- and *Trans*-2,5-Dimethylpiperazine.

RING, R. D.

Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.

Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 195-201.

In the case of the separation of mono-, di-, and triethylene glycols, the ratio of partition liquid to inert support has a profound effect. When the amount of partition liquid was reduced by one third, a reduced time of analysis, sharper peaks and no loss in resolution resulted. A similar result was apparent for *cis*- and *trans*-2,5-dimethylpiperazine.

- 1148.** Isolation and Identification of a Low Concentration Component by Gas Chromatography and Mass Spectrometry.
RIPPERE, R. E.
Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.
Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 223.
A brief description of the detection of 1,4-cyclohexadiene, 1,3-cyclohexadiene, cyclohexane and cyclohexene present as reaction products or impurities in benzene. A 4 m column packed with fluorene and picric acid on Celite with helium as carrier gas was used for the analysis.
- 1149.** The Quantitative Separation of Mixtures Containing Vinyl Acetate and Bromotrichloromethane by Vapour-Phase Chromatography.
ROBB, J. C. and VOFSI, D.
I.P. Symposium, London, 1956. 428-431.
Ed. DESTY, D. H. Published by Butterworths 1957.
The constituents were separated on a column packed with kieselguhr impregnated with 45% dinonyl phthalate. The carrier gas was nitrogen, and the constituents of the mixture were frozen out from the exit gas stream in a trap and then weighed.
- 1150.** Sepiolite: A Versatile Raw Material.
ROBERTSON, R. H. S.
Chem. and Ind. (London) 1957 (46) 1492-1495. *Chem. Abstr.* **52** 8479 (1958).
Sepiolite is essentially a hydrated magnesium silicate which can be used as a molecular sieve, and for the sorption of water and organic vapours.
- 1151.** Chromatography.
ROBINSON, C. F.
U.S. 2,845,136 (1958).
Describes a gas-liquid chromatography column built up from a stack of permeable 'Vycor' glass wafers with the edges sealed together. The wafers are coated with the stationary phase by soaking them in a solution of the stationary phase in a volatile solvent and then evaporating off the solvent.
- 1152.** Symposium on Chromatography of Gases and Vapours, London 1956.
ROCK, H.
Brennstoff-Chem. **37** 347-349 (1956).
A brief account of the Institute of Petroleum Symposium.
- 1153.** Gas Chromatography and Extractive Distillation.
ROCK, H.
Chem.-Ing.-Tech. **28** 489-495 (1956). *Chem. Abstr.* **50** 14311 (1956).
The relationship between these techniques is discussed. Experiments are described in which commercial grade butane and mixtures of benzene/cyclohexane, benzene/thiophene and heptane/methylcyclohexane were separated on columns containing various stationary phases. These were paraffin oil, aniline, quinoline, glycol and butylene glycol. It was shown from the results obtained that gas chromatographic data may be used to decide the best liquid to be used as an entrainer in extractive distillation.
- 1154.** A Catalytic Synthesis of C¹⁴ Labelled Unsaturated Hydrocarbons of the C₄ Series with the Use of Vapour-Phase Partition Radio-Chromatography.
ROGINSKY, S. Z., IANOVSKY, M. I., ZHABROVA, G. M., VINOGRADOVA, O. M., KADENATSI, B. M. and MARKOVA, Z. A.
Doklady Akad. Nauk. S.S.S.R. **121** (4) 674-677 (1958).

Describes the use of vapour-phase chromatography with radioactivity and thermal conductivity detectors for the analysis of the products of catalytic syntheses of C^{14} labelled hydrocarbons. Hydrogen or nitrogen is used as carrier gas. The radioactivity detector consists of 2 thin-walled end-window counters between which the gas flows.

1155. Quality Control of Chlorofluoromethanes and Chlorofluoroethanes by Gas Chromatography.

ROOT, M. J.

Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.

Ed. COATES, V. J., NOBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 99-103.

Describes the separation of Freons and the determination of impurities in them by the use of a 6 ft column packed with hexadecane, helium as carrier gas and thermal conductivity detection.

1156. Gas Chromatographic Analysis of Aerosol Products.

ROOT, M. J. and MAURY, M. J.

J. Soc. Cosmetic Chemists **8** 92-107 (1957). *Chem. Abstr.* **51** 9095 (1957).

A general description of gas-liquid chromatography and a detailed description of the Beckman Instrument. Mixtures of low-boiling hydrocarbons, (some fluorinated or chloro-fluorinated), are completely separated and quantitatively determined. Maximum pressures for the determination of ethanol at 20° and 40° are discussed. Traces of propellant in air and of air in propellant are determined.

1157. Gas Chromatographic Analysis of Aerosol Products.

ROOT, M. J. and MAURY, M. J.

Perfumery Essent. Oil Record **48** 88 (1957).

A review of a paper presented at a Meeting of the Society of Cosmetic Chemists. Gas Chromatography may be used for the analysis of propellants in air and air in propellants. See also the previous reference.

1158. Gas Chromatographic Analysis Applied to Aerosols.

ROOT, M. J. and MAURY, M. J.

Modern Packaging **30** (9) 169 (1957).

See reference 1156.

1159. Analysis of Volatile Aerosol Constituents.

ROOT, M. J. and MAURY, M. J.

Soap Chem. Specialities **33** (3) 75-78, 109 (1957) and **33** (4) 101, 103, 105, 107 (1957). *Chem. Abstr.* **51** 8457 (1957).

It is shown that gas chromatography can be of use both in improving existing products and for research in the development of new products.

1160. Evidence of Chromatographic Effect During Flow of Gases through Oilfield Cores.

ROPER, W. A., DOSCHER, A. and KOBAYASHI, R.

J. Petrol. Technol. **10** (3) 61-63 (1958) (*Tech. Note* 2003). *Chem. Abstr.* **52** 8515 (1958).

In many cases, oilfield cores partially saturated with oil have surface areas which are large enough to produce gas-liquid chromatographic effects.

1161. Thermal Conductivity Behaviour and its Importance in Quantitative Gas Chromatography.

ROSIE, D. M. and GROB, R. L.

Presented at 131st Nat. A.C.S. Meeting, Miami, Florida, April 1957. Abstracts p. 10B No. 28.

Although it is usually assumed that the majority of compounds analysed by gas chromatography have the same thermal conductivity, a study of this property of a variety of hydrocarbons showed that the thermal conductivities, even of similar hydrocarbons, may show significant differences even when measured against helium. Precise quantitative results may be obtained by correcting the response-output due to each compound. See also the next reference.

1162. Thermal Conductivity Behaviour. Importance in Quantitative Gas Chromatography.

ROSIE, D. M. and GROB, R. L.

Anal. Chem. **29** (9) 1263-1264 (1957). *Chem. Abstr.* **52** 4383 (1958).

The thermal conductivity behaviour of 41 hydrocarbons was investigated as a preliminary step towards the better quantitative interpretation of gas chromatographic data. The relative signal response per mole for each was determined using a 2 m column of Celite 545 impregnated with dinonyl phthalate and helium as carrier gas. The peak areas were determined by cutting out and weighing. It was found that differences in signal response for similar hydrocarbons may be significantly large.

1163. The Mass Spectrometer in the Chemical Industry.

ROSS, G. N.

Brit. Chem. Eng. **2** 614-619 (1967). *Chem. Abstr.* **52** 3423 (1958).

This article compares the techniques of gas analysis using vapour-phase chromatography, infra-red and mass spectrometry. 26 references are given.

1164. The Determination of C₃, C₄ and Higher Hydrocarbons with the Interferometer.

ROTH, F., OHME, W. and NICKISCH, A.

Oel u Kohle **38** 1133-1143 (1942). *Chem. Abstr.* **37** 6109 (1943).

Describes the use of a precalibrated interferometer for following the course of adsorption and desorption of gases on activated charcoal and full experimental details are given.

1165. The Chromatographic Method for Analysis of Gases and Vapours.

ROUIT, C.

Rev. inst. franc. pétrole et Ann. combustibles liquides **11** (2) 213-230 (1956). *Chem. Abstr.* **50** 13660 (1956).

Only the title is listed in *Chem. Abstr.* A review of the various methods employed by various authors in the application of gas chromatography. A section on detectors includes a description of thermal conductivity, the gas density balance and the measurement of surface potentials.

1166. The Analysis and Control of Refinery Gas Streams using the Chromatographic Technique (Janak Method).

ROUIT, C.

I.P. Symposium, London, 1956. 291-303.

Ed. DESTY, D. H. Published by Butterworths 1957.

The method uses Janak's technique with carbon dioxide as carrier gas and direct measurement of eluted components after absorption of carbon dioxide by potassium hydroxide.

- 1167.** The Physical Properties of some Fluorine Compounds and their Solutions. III. Perfluorocyclohexane and Perfluoromethylcyclohexane.
ROWLINSON, J. S. and THACKER, R.
Trans. Faraday Soc. **53** (1) 1-8 (1957). *Chem. Abstr.* **51** 10156 (1957).
The properties of the pure compounds and their mixtures are given. Gas chromatography was used as a sensitive test for impurities in these compounds. The analysis was carried out on a 2 m column of Celite 545 impregnated with dinonyl phthalate at 75°C, using nitrogen as carrier gas.
- 1168.** Adsorption of Gases on Asbestos.
ROZHDESTVENSKII, V. P.
Trudy, Nauch.-Issledovatel. Inst. Geofiz. i. Geokhim. Metadov. Rozvedki 1954 (2) 55-58. *Chem. Abstr.* **51** 13509 (1957).
It was found that compact cylinders of asbestos adsorbed hydrocarbons and nitrous oxide at room temperature.
- 1169.** High Temperature Gas Chromatography.
RUBY, E. D.
Presented at 6th Ann. Anachem. Conf. Detroit, October 1958.
No further details are available.
- 1170.** Gas Chromatography and its Application to Industrial Hygiene and Air Pollution Problems.
RUSHING, D. E.
Presented at Ann. Meeting, Am. Ind. Hygiene Assoc., Kiel Auditorium, St. Louis, U.S.A., April 1957. Printed in Am. Ind. Hygiene J. **19** (3) 238-245 (1958).
A description is given of the basic principles and apparatus of gas chromatography, and applications of the method both present and potential in the field of industrial hygiene and air pollution. The limitations of the method are briefly discussed.
- 1171.** Transfer Cell for Gas Chromatography.
RUSSELL, D. S. and BEDNAS, M. E.
Anal. Chem. **29** (10) 1562 (1957). *Chem. Abstr.* **52** 1692 (1958).
Describes a device for transferring a whole (but very small) sample to a chromatographic unit. As little as 10^{-6} mole of sample can be transferred with this cell.
- 1172.** Recording Methane Meter for Underground Use in Coal Mines.
RUTTE, W. A. le., WEEDA, W. and MAAS, W.
Appl. Sci. Res. **6A** 67-81 (1956). *Chem. Abstr.* **51** 9 (1957).
In English. 0-2% methane in air may be measured on the instrument described, which is based on thermal conductivity. Complete details of construction and operation are given.
- 1173.** Analysis of Volatile Organic Sulphur Compounds by Gas Partition Chromatography.
RYCE, S. A. and BRYCE, W. A.
Anal. Chem. **29** (6) 925-928 (1957). *Chem. Abstr.* **51** 11935 (1957).
The article describes the separation of hydrogen sulphide, methyl, ethyl and propyl mercaptans, dimethyl and diethyl sulphides and thiophene, and the separation of the sulphur compounds from ethanol and methanol. The chromatographic separations were carried out on a 4 ft × 5 mm column of Celite 545 impregnated with tricresyl phosphate, using helium as carrier gas with thermal conductivity detection.

1174. Ionisation Gauge Detector for Gas Chromatography.

RYCE, S. A. and BRYCE, W. A.

Nature **179** (4558) 541 (1957). *Chem. Abstr.* **51** 10135 (1957).

A sensitive ionisation gauge detector has been developed which makes use of the fact that the ionisation potential of helium carrier gas is very much greater than that of most other volatile substances. The gauge and its associated adjustable metal leak are shown. Typical operating conditions are given, and the sensitivity obtained so far is at least 200 times that given by a thermistor type thermal conductivity cell. See also the following reference.

1175. An Ionisation Gauge Detector for Gas Chromatography.

RYCE, S. A. and BRYCE, W. A.

Can. J. Chem. **35** (11) 1293-1297 (1957). *Chem. Abstr.* **52** 3414 (1958).

A more detailed report of the material described in the previous reference.

1176. Thermal Conductivity Cell for Gas Chromatography.

RYCE, S. A., KEBARLE, P. and BRYCE, W. A.

Anal. Chem. **29** (9) 1386-1387 (1957). *Chem. Abstr.* **52** 5891 (1958).

Full details of the construction and performance of the cell are given. It will detect as little as 10^{-8} mole of material.

1177. Apparatus for Adsorption Analysis of Gases and Liquids.

SALL, A. O.

U.S.S.R. 109,939 (1958). *Chem. Abstr.* **52** 14247 (1958).

Only the title is listed in *Chem. Abstr.*

1178. Physical Analysis of Gases.

SAND, P. T.

Can. Chem. Processing **41** (5) 114-120 (1957). *Chem. Abstr.* **51** 17599 (1957).

A review which includes descriptions of thermal conductivity apparatus and infra-red analysis, and states precautions which must be taken during measuring, especially when working with corrosive gases.

1179. Chromatography of High Molecular Weight Aliphatic Compounds.

SAVIDAN, L.

Oléagineux **13** 207-208 (1958). *Chem. Abstr.* **52** 11518 (1958).

Describes the use of adsorption chromatography on activated carbon for the separation of hydrocarbons in the C_{28} - C_{36} range. It is mentioned that the higher fatty acids can also be studied by the same technique.

1180. Laboratory Instrumentation Moves into Plant.

SAVITZKY, A.

Anal. Chem. **30** (3) 17A (1958).

A description of modifications necessary to the design of infra-red and gas chromatography analysers in order to fit them for monitoring process streams in the plant.

1181. Thermal Conduction and Gas Analysis.

SAXENA, S. C.

Nature **178** (4548) 1462 (1956). *Chem. Abstr.* **51** 7237 (1957).

Discusses the use of a thermal conductivity apparatus in which the theory is completely understood and the various corrections are exactly calculable. Mixtures of helium/xenon, argon/xenon, argon/helium and neon/argon were used in the investigation.

- 1182.** Thermal Conductivity of Binary and Ternary Mixtures of Helium, Argon and Xenon.
SAXENA, S. C.
Indian J. Phys. **31** 597-606 (1957). *Chem. Abstr.* **52** 13399 (1958).
Thermal conductivities are reported and a formula developed which permits the calculation of the thermal conductivities of ternary mixtures.
- 1183.** Gas Chromatography.
SCHAMP, N.
Mededel Vlaam Chem. Ver. **19** 53 (1957).
In Flemish. No further details are available.
- 1184.** Gas-Adsorption Measurements in Flow Systems.
SCHAY, G. and SZEKELY, G.
Acta Chim. Acad. Sci. Hung. **5** 167-182 (1954). *Chem. Abstr.* **50** 7540 (1956).
In English. A method is described which is based on frontal chromatographic analysis. Experiments were carried out on silica gel using carbon dioxide as adsorbate and hydrogen as carrier gas, under conditions similar to those in a catalytic reactor.
- 1185.** Determination of Adsorption Isotherms by Vapour-Phase Chromatography.
SCHAY, G., FEJES, P., HALASZ, I. and KIRALY, J.
Magyar Kem. Folyoirat **63** 143-149 (1957). *Chem. Abstr.* **52** 17892 (1958).
The adsorption isotherms of carbon dioxide between 20 and 60°C were determined on activated carbon by the method described in the previous reference.
- 1186.** Determination of Adsorption Isotherms by Frontal Gas Chromatography.
SCHAY, G., FEJES, J., HALASZ, I. and KIRALY, J.
Acta Chim. Acad. Sci. Hung. **11** 381-393 (1957). *Chem. Abstr.* **51** 15216 (1957).
In English. See the previous reference for details.
- 1187.** Adsorption of Gas Mixtures. I. Statistical Theory of Physical Adsorption of the Langmuir Type in Multicomponent Systems.
SCHAY, G., FEJES, P. and SZATHMARY, J.
Acta Chim. Acad. Sci. Hung. **12** 299-306 (1957). *Chem. Abstr.* **52** 8674 (1958).
In English. The theory of adsorption was discussed, and a modified Langmuir equation was extended in scope in order to cover a mixture of any number of components.
- 1188.** Adsorption of Gas Mixtures. II. New Chromatographic Method for Determination of Mixed Adsorption; Adsorption of CO_2 - C_2H_2 Mixtures on Charcoal.
SCHAY, G., SZEKELY, G. and SZIGETVARY, G.
Acta Chim. Acad. Sci. Hung. **12** 309-323 (1957). *Chem. Abstr.* **52** 8674 (1958).
The theory put forward in the previous reference was tested for the adsorption of carbon dioxide, acetylene and mixtures of the two, on activated carbon.

1189. Determination of Adsorption Isotherms of Gases by Frontal Chromatography.

SCHAY, G., SZEKELY, G. and FEJES, P.

Hua Hsueh Hsueh Pao **23** 421-427 (1957). *Chem. Abstr.* **52** 19338 (1958).

An English translation is given in pages 427 to 437 of this Journal. The basis of a new method described is given by measuring and comparing the rates at which gases enter and leave the adsorption system.

1190. Fractionation of Gases with Solid Adsorbents.

SCHEELINE, H. W.

U.S. 2,523,149 (1950). *Chem. Abstr.* **44** 10388 (1950).

An intermediate component may be concentrated from a vapour mixture which also contains more readily and less readily adsorbed components by means of a fluidised solid adsorbent. Application of this technique mentioned include the recovery of ethane and C_3 hydrocarbons from refinery gas, the recovery of light ends from catalytic cracking gases, and the separation of deuterium from hydrogen.

1191. Response Time and Flow Sensitivity for Detectors for Gas Chromatography.

SCHMAUCH, L. J.

Presented at Meeting of Div. of Petrol. Chem. of A.C.S., Chicago, September 1958. Printed in A.C.S. General Papers of Div. of Petrol. Chem. **3** (3) 145-155 (1958).

Experiments showed the effect of response time on the separation of adjacent bands, as well as how both parameters change with operating conditions. The results of the study provide criteria for judging the adequacy of a detector.

1192. Precision Gas Mixer for Calibrating Analysers.

SCHNELLE, P. D.

ISA Journal **4** 128-133 (1957). *Chem. Abstr.* **51** 15184 (1957).

A continuous-flow gas-dilution apparatus is described, which has 2 flow systems to blend the gases to be mixed. In order to minimise corrosion and other effects, the gases are only brought into contact with glass, Teflon and sapphire.

1193. The Quantitative Evaluation of Fractograms from Partition Chromatography.

SCHOMBURG, G.

Presented at Meeting on 'The Analysis of Gaseous and Liquid Hydrocarbons and their Derivatives by Physical Methods'. Essen, January 1958. Printed in Z. anal. Chem. **164** (1) 147-158 (1958).

In German. Numerous experiments on the calibration of katharometers are reported and comparisons made between the results obtained from peak heights and peak areas on samples of known composition.

1194. Continuous Determination of C^{14} and S^{35} in Aqueous Media. Application to Chromatographic Effluents.

SCHRAM, E. and LOMBAERT, R.

Anal. Chim. Acta **17** (4) 417-422 (1957). *Chem. Abstr.* **52** 4394 (1958).

In French. A recording apparatus is described, based on the spreading of the liquid in a thin layer in contact with a plastic scintillator coupled to a coincidence circuit.

1195. Gasanalyse in Der Technik.

SCHUFTAN, P.

Published in Leipzig, 1931.

This is a book which describes early types of thermal conductivity cells. No further details are available.

1196. Gas Chromatographic Analysis. A Modern Rapid Method for Gas Analysis.

SCHUHKNECHT, W.

Arch. Eisenhuttenw. **29** (2) 101-106 (1958). *Chem. Abstr.* **52** 7936 (1958).

Gives a detailed description of frontal analyses, displacement analysis and elution analysis, and the apparatus used. Practical examples from industry are used as illustrations.

1197. Substitute for Podbielniak Distillation by a Combination of Gas Chromatography and Gravimetry.

SCHWENK, U. and WEBER, E.

Presented at Meeting on 'The Analysis of Gaseous and Liquid Hydrocarbons and their Derivatives by Physical Methods'. Essen. January 1958. Printed in Z. anal. Chem. **164** (1) 159-163 (1958).

In German. Refinery gas samples containing C_5 and higher hydrocarbons were analysed by distillation and by gas chromatography, with good agreement between the 2 methods. The C_5 + hydrocarbons were determined in the gas chromatographic method by reversing the flow of carrier gas so as to remove them from the column for collection by adsorption and weighing.

1198. A New Detector for Vapour-Phase Partition Chromatography.

SCOTT, R. P. W.

Nature **176** 793 (1955). *Chem. Abstr.* **50** 13519 (1956).

Detection is based on the measurement of the temperature of the flame when the exit gas is burned at a small jet. It can be used with hydrogen or a gaseous mixture containing hydrogen as a carrier gas. The presence of an organic vapour causes the flame to lengthen and engulf a thermocouple. The investigation was carried out on a column of Celite impregnated with paraffin.

1199. A New Detector for Vapour-Phase Partition Chromatography.

SCOTT, R. P. W.

I.P. Symposium, London, 1956. 131-145.*Ed. DESTY, D. H. Published by Butterworths 1957.*

Uses hydrogen or a gaseous mixture containing hydrogen as a carrier gas. The temperature of the flame is measured when the exit gas is burnt at a small jet. See the previous reference.

1200. Application of Gas-Liquid Chromatography to Hydrocarbon Analysis.

SCOTT, R. P. W.

Benzol Producers Ltd., Research Paper 4-1957. 68 pp.

A general descriptive paper on the construction of routine equipment employing a flame detector. The factors affecting column efficiency are investigated, and the conditions for obtaining optimum efficiency from a 5 ft partition column are listed.

1201. Retention Ratios for Hydrocarbons.

SCOTT, R. P. W.

Benzol Producers Ltd., Research Paper 8-1957.

Lists relative retention volume data for 4 stationary phases on a column containing 20% stationary phase on 80-100 mesh C22 firebrick. The stationary phases are:—Apiezon oil 'A' at 65°C, and also at 101°C, polyethylene glycol 1000 at 78°C and dinonyl phthalate at 118°C.

1202. The Construction of High-Efficiency Columns for the Separation of Hydrocarbons.

SCOTT, R. P. W.

Gas Chromatography 1958. *Amsterdam Symposium—May 1958.*

Ed. DESTY, D. H. Published by Butterworths 1958. 189-196. Discussion 196-199.

The effects of column diameter and inlet/outlet pressure ratios on the height of the theoretical plate of high efficiency columns are investigated. The conditions for constructing a column that will have an efficiency range between 18,000 and 30,000 theoretical plates are described.

1203. High Efficiency Columns for the Analysis of Hydrocarbons by Gas-Liquid Chromatography.

SCOTT, R. P. W. and CHESHIRE, J. D.

Nature **180** (4588) 702-703 (1957). *Chem. Abstr.* **52** 3414 (1958).

Using the conditions specified, column efficiencies of 12,000 theoretical plates may be obtained. The conditions are given in detail, and cover every aspect of the apparatus, column packing and operating conditions.

1204. Infra-Red Indication in Gas Chromatography.

SEKERKA, B., SPEVAK, A. and FRIEDRICH, K.

Chem. prumysl. **7** (11) 602-604 (1957). *Chem. Abstr.* **52** 13515 (1958).

In Czech. with an English summary. Thermistors have been applied to the infra-red determination of components separated by gas chromatography.

1205. Vapour-Phase Chromatography in Tobacco Research.

SELIGMAN, R. B.

Presented at Symposium on Recent Developments in Research Methods and Instrumentation, Bethesda, Maryland, May 1956. Abstract in Anal. Chem. **28** (6) 1058 (1956).

The nature of cigarette smoke can be evaluated by the use of gas chromatography in conjunction with mass spectrometry. A full description of the apparatus used is given.

1206. Novel Applications of Gas Chromatography.

SELIGMAN, R. B.

Presented at South Eastern Regional Meeting of Local Sections of A.C.S. Durham, N.C., November 1957.

No further details are available.

1207. Vapour-Phase Chromatography in Tobacco Research.

SELIGMAN, R. B., RESNIK, F. E., O'KEEFE, A. E., HOLMES, J. C., MORRELL, F. A., MURRILL, D. P. and GAGER, F. L.

Presented at 129th National A.C.S. Meeting, Dallas, Texas, April 1956. Abstracts p. 19B No. 51.

Gives a brief description of the apparatus used. It has been found that single columns give poorly defined separations because of the large number of compounds present, but by repeated separations using different stationary liquids, several pure compounds have been isolated.

1208. Gas Chromatography in Tobacco Research.

SELIGMAN, R. B., RESNIK, F. E., O'KEEFE, A. E., HOLMES, J. C., MORRELL, F. A., MURRILL, D. P. and GAGER, F. L.

Tobacco **145** (9) 24-29 (1957). *Chem. Abstr.* **51** 17107 (1957).

See the previous reference.

1209. Chromatographic Analysis.

SENYAVIN, M. M.

Zhur. Anal. Khim. **12** (5) 637-646 (1957). *Chem. Abstr.* **52** 2637 (1958).

A review article. An English translation is available in *J. Anal. Chem. U.S.S.R.* **12** 655 (1957).

1210. Recording Nitrometer Detector for Gas Chromatography.

SEVENSTER, P. G.

S. African Ind. Chemist **12** 75-76 (1958). *Chem. Abstr.* **52** 17822 (1958).

Carbon dioxide carrier gas sweeps the eluted components into a nitrometer containing potassium hydroxide. An integral recording detector automatically records a chromatogram, and components are identified by their retention times.

1211. Degradation of Protein in the Rumen of the Sheep. I. Some Volatile Fatty Acids Found *in Vivo*.

SHAZLY, K. el.

Biochem. J. **51** 642-647 (1952). *Chem. Abstr.* **46** 11270 (1952).

Using the gas-liquid partition chromatographic method of James and Martin, it was found that branched-chain lower fatty acids occur in the rumen of the sheep on a variety of diets.

1212. Degradation of Protein in the Rumen of the Sheep. II. The Action of Rumen Micro-Organisms on Amino Acids.

SHAZLY, K. el.

Biochem. J. **51** 647-653 (1952). *Chem. Abstr.* **46** 11270 (1952).

The volatile fatty acids were analysed by gas-liquid chromatography in a quantitative study of the products formed from casein hydrolysis by a washed suspension of rumen micro-organisms.

1213. Apparatus for Continuous Isotopic Analysis of Hydrogen-Deuterium Mixtures.

SILVESTRI, M. and ADORNI, N.

Nuovo cimento **4** 1610 (1956).

A method based on thermal conductivity is described. See the following reference.

1214. Continuous Measurement of Deuterium Concentration in Hydrogen by Means of Thermal Conductivity.

SILVESTRI, M. and ADORNI, N.

Rev. Sci. Instr. **27** (6) 388-391 (1956). *Chem. Abstr.* **51** 12558 (1957).

The method used is based on the difference in the thermal conductivities of hydrogen and deuterium. A continuous measuring device is described.

1215. Two-Stage Gas-Liquid Chromatography.

SIMMONS, M. C. and SNYDER, L. R.

Presented at 131st Nat. Meeting, A.C.S., Miami, Florida, April 1957. Abstracts p. 18Q No. 60.

An apparatus has been designed for connecting 2 or more columns so that preliminary separations may be carried out on the first column, and the separated fractions fed directly to the second column for more detailed resolution.

1216. Two-Stage Gas-Liquid Chromatography.

SIMMONS, M. C. and SNYDER, L. R.

Am. Chem. Soc. Div. Petrol. Chem. Gen. Papers **2** (1) 401-410, March 1957.

See both the previous and following references.

1217. Two-Stage Gas-Liquid Chromatography.

SIMMONS, M. C. and SNYDER, L. R.

Anal. Chem. **30** (1) 32-35 (1958). *Chem. Abstr.* **52** 8519 (1958).

An arrangement has been devised for connecting 2 or more columns in such a manner that preliminary cuts prepared by the first column can be charged directly to one or more secondary columns.

1218. Gas Chromatography.

SIMON, R. H. M.

Chem. Eng. News **34** 2350 (1956).

A general descriptive article.

1219. Ion Exclusion—Column Analysis.

SIMPSON, D. W. and WHEATON, R. M.

Chem. Eng. Progr. **50** (1) 45-49 (1954). *Chem. Abstr.* **48** 2423 (1954).

The article discusses theory, applications and operating conditions for ion exclusion, particularly with reference to column efficiency. A longer abstract is given in *Chem. Abstr.*

1220. Gas Chromatography: Sample Introduction, Detectors and Recorders.

SINGER, P. D.

Presented at 31st Ann. Meeting, California Natural Gas Assoc., Los Angeles, November 1956. Reported in Oil Gas J. **54** (85) 132-134 (1956).

A description of sample injection methods with particulars of a sampling device suitable for both gases and liquids, and notes on thermal conductivity detectors and recorders.

1221. Flow Controllers.

SKROKOV, M. R.

Power **101** (2) 98 (1957).

Describes, with theoretical considerations, various types of flow controller including proportional response, automatic-reset response, derivative response and a stacked diaphragm response. It describes controller mechanisms, on-off response, miniature controllers and gives some notes on special controllers.

1222. Gas Chromatography in the Food Industry.

SLOMAN, K. G. and BORKER, E.

Presented at Sectional Meeting A.C.S. New York, March 1956.

No further details are available, but the paper is referred to in *Anal. Chem.* **28** (3) 28A (1956). See also the following reference.

1223. Vapour-Phase Chromatography—A Preliminary Investigation of Applications in a Food Laboratory.

SLOMAN, K. G. and BORKER, E.

Presented at 129th National A.C.S. Meeting, Dallas, Texas, April 1956.

A description of the apparatus used in the investigation is given. It is considered that gas chromatography will be useful in quality control work, and that volatile raw materials can easily be checked for purity and identity. The volatile constituents of flavours can be identified by this method.

1224. Fractionation with Solid Adsorbents in a Single Column.

SMALL, J. K.

U.S. 2,548,502 (1951). *Chem. Abstr.* **45** 5467 (1951).

Describes the use of an adsorption column 140 ft high and 10 ft diameter, complete with heating and cooling sections. Adsorption and rectification zones are each about 20 ft long and activated charcoal is used as adsorbent. More details are given in *Chem. Abstr.*

1225. Theory of Chromatography. I.

SMIT, W. M. and HOEK, A. van den.

Rec. trav. chim. **76** 561-576 (1957). *Chem. Abstr.* **51** 15216 (1957).

Describes a modification to De Vault's theory of the chromatography of binary mixtures. Preferential instead of absolute adsorption isotherms are used since these may be determined experimentally. Part II of this article is reported in reference 645.

1226. The Analysis of Light Hydrocarbon Mixtures by Gas Chromatography.

SMITH, D. E., FAVRE, J. A. and HINES, W. J.

Presented at Southwest Regional Meeting A.C.S. Local Sections, Tulsa, Oklahoma, December 1957.

No further details are available.

1227. Chromatographic Analysis of Gas Mixtures Containing Nitrogen, Nitrous Oxide, Nitric Oxide, Carbon Monoxide and Carbon Dioxide.

SMITH, R. N., SWINEHART, J. and LESNINI, G. D.

Anal. Chem. **30** (7) 1217-1218 (1958). *Chem. Abstr.* **52** 14417 (1958).

These gases were separated on a column consisting of 2 layers of silica gel separated by iodine pentoxide, using a column temperature of 115°C, helium as carrier gas, and thermal conductivity detection. Simple gas sampling and gas transfer units are also described.

1228. Fluorocyclohexanes. I. *Cis*- and *Trans*-1H:2H-Decafluorocyclohexanes.

SMITH, R. P. and TATLOW, J. C.

J. Chem. Soc. 1957 2505-2511. *Chem. Abstr.* **51** 14568 (1957).

Improved conditions are described for the preparation of polyfluorocyclohexanes by treatment of benzene with cobaltic fluoride at 150-200°C. The investigations were considerably simplified by the application of gas chromatography.

1229. Studies of Diffusion Flames: Some Ketone Flames.

SMITH, S. R. and GORDON, A. S.

Presented at 131st Nat. Meeting, A.C.S., Miami, Florida, April 1957. Abstracts p. 51R No. 127.

The precombustion products of the diffusion flames of some ketones were removed through fine quartz probes from various positions in the flame and were analysed by gas chromatography and mass spectrometry.

- 1230.** Diffusion Flames. III. The Diffusion Flames of the Butanols.
SMITH, S. R., GORDON, A. S. and HUNT, M. H.
J. Phys. Chem. **61** 553-558 (1957). *Chem. Abstr.* **51** 13530 (1957).
Samples of the precombustion products were removed from the diffusion flames of the 4 isomeric butanols using a quartz probe technique and analysed by a combination of mass spectrometric and gas chromatographic analysis.
- 1231.** The Chromomax and the Characteristics of Leeds and Northrup Thermal Conductivity Detectors.
SNOWDEN, F. C. and EANES, R. D.
Presented at 2nd Delaware Valley Regional A.C.S. Meeting, Philadelphia, February 1958.
No further details are available.
- 1232.** Improvements in the Detection and Estimation of the Content of a Given Gas in a Gaseous Mixture by Thermal Conductivity.
Soc. Anon. des Manufactures des Glaces et Produits Chimiques de Saint Gobain, Chauvey et Cirey. B.P. 768,344 (1952). *Anal. Abstr.* **4** 3198 (1957).
A description is given of a thermal conductivity gauge which has been used for the determination of hydrogen in air.
- 1233.** The Separation of Naphthalene and its Hydrogenation Products by Vapour-Phase Chromatography.
SOEMANTRI, R. M. and WATERMAN, H. I.
J. Inst. Petrol. **43** (399) 94-99 (1957). *Chem. Abstr.* **51** 7239 (1957).
Separation of these compounds has been carried out on columns of both Celite impregnated with D.C. Silicone 702 and firebrick impregnated with dioctyl phthalate. A good separation was obtained in both cases at 170°C using thermal conductivity detection. The columns were found to be quite stable, no signs of a decline in separating efficiency being observed during the course of the investigation.
- 1234.** Gas-Adsorption Chromatography with Thermal Conductivity Indication.
SOKOL, L.
Chem. promysl **7** (4) 189-190 (1957). *Chem. Abstr.* **52** 2639 (1958).
The separation of C_1 - C_5 hydrocarbons has been carried out on alumina using hydrogen as carrier gas. Detection is by thermal conductivity which is recorded automatically.
- 1235.** Chromatographic Analysis of C_1 - C_4 Hydrocarbons and of certain Non-Hydrocarbon Gases.
SOKOLOV, V. A. and KUZ'MINA, L. P.
Zavodskaya Lab. **23** (9) 1034-1037 (1957). *Anal. Abstr.* **5** 2670 (1958).
Describes the separation of hydrogen, carbon monoxide and C_1 - C_4 hydrocarbons on an apparatus containing 3 columns which may be filled with different adsorbents. More details are given in *Anal. Abstr.*
- 1236.** Application of some Minerals with Different Adsorption Capacities for Chromatographic Analysis of Gases.
SOKOLOV, V. A., ANDRONIKASHVILI, T. G., KUZ'MINA, L. P. and SHISHKOVA, V. P.
Khim. i Tekhnol. Topliva i Masel 1957 (10) 61-65. *Chem. Abstr.* **52** 4397 (1958).
The properties of serpentine, natrolite, kaolin, diatomite and silica gel are given, and their use in the separation of carbon monoxide, hydrogen and C_1 - C_7 hydrocarbons is compared.

- 1237.** Low-Resistance Vapour-Phase Chromatograph Column.
SORENSEN, I. and SOLTOFT, P.
Acta Chem. Scand. **10** 1673-1674 (1956). *Chem. Abstr.* **52** 12464 (1958).
In English. Describes the use of 1.6×1.6 mm stainless steel gauze helices as a column packing material for the separation of high boiling compounds.
- 1238.** Gas-Liquid Chromatography Determination of the Fatty Acid Composition in Oil from Seeds of *Ulmus*.
SORENSEN, I. and SOLTOFT, P.
Acta Chem. Scand. **12** 814-822 (1958).
Using a stainless steel column, silicone grease as stationary phase, a coiled platinum wire thermal conductivity cell and nitrogen as carrier gas, methyl esters of the fatty acids were determined. The statement in the literature that a surprisingly high content of C_{10} fatty acid is present has been confirmed. A method of sample introduction involving the breaking of a glass ampoule is described.
- 1239.** Punched Card Storage of Gas Chromatographic Data.
SPENCER, C. F. and JOHNSON, J. F.
Anal. Chem. **30** (5) 893-894 (1958). *Chem. Abstr.* **52** 11493 (1958).
Describes the use of an IBM punched card system.
- 1240.** Gas Odourants Analysis by Gas Chromatography.
SPENCER, C. F., BAUMANN, F. and JOHNSON, J. F.
Anal. Chem. **30** (9) 1473-1474 (1958). *Chem. Abstr.* **52** 20993 (1958).
Describes the use of gas chromatography for the analysis of mercaptan and sulphide compounds commonly occurring in gas odourants, on a column of C22 firebrick impregnated with dinonyl phthalate. The column was operated at 50°C , and helium was used as carrier gas.
- 1241.** An Examination of the Distillation Characteristics of Hydrorefined Benzole.
SPENCER, D.
Ind. Chemist **34** (400) 287-293 (1958). *Chem. Abstr.* **52** 14139 (1958).
Describes use of gas chromatography in the analysis of complex mixtures of paraffins and aromatics.
- 1242.** Separation of Mixtures of Hydrocarbons by Adsorptive and Preparative Methods and their Application on Waxes.
SPENGLER, G. and HAUF, G.
Fette, Seifen, Anstrichmittel **59** 509-514 (1957). *Chem. Abstr.* **52** 17759 (1958).
Describes the use of a column of silica gel from which the adsorbed components are eluted according to a detailed procedure. The method is suitable for the separation of higher molecular weight waxes into their components.
- 1243.** Adsorptive Chromatographic Separation of Waxes and Their Components.
SPENGLER, G. and WOLLNER, E.
Fette, Seifen, Anstrichmittel **56** 775-784 (1954). *Chem. Abstr.* **50** 7482 (1956).
Describes the behaviour of the various wax components on various adsorbents. Many graphs are given in illustration.

- 1244.** Plant Stream Gas Analyser.
SPRACKLEN, S. B.
Presented at New Jersey Sect. Meeting, Instr. Soc. Amer., Newark, N.J., April 1957.
No further details are available, but see the following reference.
- 1245.** Development of Gas Chromatographs.
SPRACKLEN, S. B.
ISA Journal **4** 514-517 (1957). *Chem. Abstr.* **52** 8632 (1958).
An apparatus is described which will continuously record the purity of a stream of chlorine of 95-100% purity. All operational details are given.
- 1246.** Development of a Process Gas Chromatographic Analyser.
SPRACKLEN, S. B.
Proc. Control **5** (3) 81 (1958).
See the previous reference.
- 1247.** Formulas for Thermal Conductivity of Ternary Gas Mixtures.
SRIVASTAVA, B. N. and SAXENA, S. C.
J. Chem. Phys. **27** 583-584 (1957). *Chem. Abstr.* **52** 13400 (1958).
A comparison of various formulas for calculating thermal conductivities.
- 1248.** Thermal Conductivity of Binary and Ternary Rare Gas Mixtures.
SRIVASTAVA, B. N. and SAXENA, S. C.
Proc. Phys. Soc. (London) **70B** 369-378 (1957). *Chem. Abstr.* **52** 13400 (1958).
The thermal conductivities of mixtures of neon/argon, neon/krypton and argon/krypton are reported. These were measured at 38°C for various concentrations by a 'thick wire' variant of the 'hot wire' method.
- 1249.** Chemical Varieties of Plants Containing Terpenoids.
STAHL, E.
Essenze deriv. agrumari **27** 188-207 (1957). *Chem. Abstr.* **52** 10507 (1958).
Gas chromatography shows great promise in helping to solve the many analytical problems involved.
- 1250.** Gas Chromatography and Mass Spectrometry.
STAHL, W. H.
Quartermaster Food and Container Inst., Surveys Progr. Military Subsistence Problems, Ser. 1. (9) 58-75 (1957). *Chem. Abstr.* **52** 2290 (1958).
A combination of these methods may be used to isolate and identify the components of odours.
- 1251.** Application of Isolative Vapour-Phase Chromatography to Problems in Food Research.
STAHL, W. H. and LEVY, E. J.
Presented at Symposium on Recent Developments in Research Methods and Instrumentation, Bethesda, Maryland, May 1956. Abstract in Anal. Chem. **28** (6) 1058 (1956).
A description of the use of gas chromatography in conjunction with mass spectrometry, and its application to work on organic sulphur compounds contributing to the development of odours in food.
- 1252.** A New Sample Injection Method for Gas-Liquid Chromatography.
STANFORD, F. G.
U.K. Atomic Energy Authority, RCC/R-86 (1958) 4 pp.

A method is described for the injection of accurately known weights of sample. It is of particular value when the amount of sample available is limited.

1253. Terpene Formation in Pine from Mevalonic Acid.

STANLEY, R. G.

Nature **182** (4637) 738-739 (1958). *Chem. Abstr.* **53** 5414 (1959).

α -Pinene was separated by gas chromatography on a column of Carbowax 1540 on diatomaceous earth, using helium as carrier gas. See also the following reference.

1254. Terpene Analysis by Gas Chromatography.

STANLEY, R. G. and MIROV, N. T.

Presented at 133rd National Meeting, A.C.S., San Francisco, April 1958. Abstract p. 7A No. 16.

The method of gas-liquid partition chromatography offers great advantages due to its sensitivity, small sample requirement, rapidity and availability of samples for subsequent analysis. Its use in the analysis of plant turpentine constituents or as an aid in the study of the origin of terpenes in pine is discussed. See also the previous reference.

1255. Sonic Gas Analysers and Their Industrial Uses.

STEELE, D. I. and KNIAZUK, M.

IRE, Trans. on Ind. Electronics PGIE-6, 64-67 (1958). *Chem. Abstr.* **52** 15149 (1958).

The analyser is described, and it is suggested that it could be used as a detector in gas chromatography.

1256. Mass Spectrographic and Gas Chromatographic Study of the Thermal Reactions of Acetylene.

STEHLING, F. C., COATS, F. H. and ANDERSON, R. C.

Presented at 132nd Meeting, A.C.S., New York, September 1957. Abstract p. 23S No. 59.

Gas-liquid partition chromatography was used to analyse the products formed in the early stages of the reaction of acetylene-helium mixtures at 600-900°C. No experimental details are given in the abstract.

1257. Pentafluorobenzene.

STEPHENS, R. and TATLOW, J. C.

Chem. and Ind. (London) 1957 821-822. *Chem. Abstr.* **51** 16322 (1957).

An extension of methods employed for hexafluorobenzene has led to the synthesis of pentafluorobenzene. See reference 519.

1258. Chromatography, General Principles and Applications.

STERESCU, M.

Rev. chim. (Bucharest) **8** 535-540 (1957). *Chem. Abstr.* **52** 1725 (1958).

A review containing 28 references.

1259. Analysis of Ortho- and Para-Hydrogen Mixtures by the Thermal Conductivity Method.

STEWART, A. T. and SQUIRES, G. L.

J. Sci. Instr. **32** (1) 26-29 (1955). *Chem. Abstr.* **49** 7309 (1955).

The thermal conductivity cell used is described and full details are given of the method of operation.

- 1260.** Micro Infra-red Analyses as Applied to Gas Chromatography Fractions.
STEWART, J. E. and GALLAWAY, W. S.

Presented at the 9th Annual Symposium of the Am. Assoc. of Spectrographers, Chicago, June 1958. Abstract in Spectrochim. Acta **13** (1/2) 154 (1958).

The design and performance of an infra-red system was illustrated by studies on major and minor constituents isolated from diverse mixtures by gas chromatography.

- 1261.** Chromatography. Analysis by Differential Migration.

STRAIN, H. H.

Anal. Chem. **30** (4) 620-629 (1958). *Chem. Abstr.* **52** 9847 (1958).

Only the title is listed in *Chem. Abstr.* The article contains sections on gas chromatography, and an excellent table comparing the different types of chromatography is included.

- 1262.** The Selective Measurement of one Gas in a Multicomponent Mixture.
STRANGE, J. P.

Can. Chem. Processing **40** (9) 95 (1956).

Describes a thermal conductivity instrument and gives full details of the construction, with diagrams. It also describes how the instrument can be made selective for one gas.

- 1263.** A Scintillation Counter for the Assay of Radioactive Gases.

STRANKS, D. R.

J. Sci. Instr. **33** 1-4 (1956). *Chem. Abstr.* **50** 6102 (1956).

A plastic scintillator serving as one wall of a glass chamber can be used for the assay of C^{14} . Using this instrument, carbon dioxide tagged with C^{14} can be assayed in the presence of other gases.

- 1264.** Chromatographic Gas Analysis.

STRATEN, H. A. C. van.

Zakenwereld (Amsterdam) **34** 46 (1956).

No further details are available.

- 1265.** Chromatographic Gas Analysis.

STRATEN, H. A. C. van.

Chem. En. Pharm. Tech. (Dordrecht) **12** 6 (1957).

No further details are available.

- 1266.** Synthetic Ion Exchangers as Molecular Sieves.

STREATFIELD, E. L.

Génie chim. **78** 161-172 (1957). *Chem. Abstr.* **52** 7811 (1958).

A review of the properties and method of operation of ion exchangers, and their application to the separation of mixtures.

- 1267.** New Method of Integration Recording.

STRICKLER, A. and GALLAWAY, W. S.

Presented at Conf. on Anal. Chem., Pittsburgh, March 1958. Paper 113.

No further details are available.

- 1268.** The Evaluation and Construction of Efficient Separating Columns.

STRUPPE, H. G.

Presented at Symposium on Gas Chromatography, Leipzig, October 1958. Preprints 197-235.

In German. Methods of measuring column efficiency are discussed together with the effects on efficiency of temperature, particle size, column pressure and length, sample size and impregnation of solid support.

- 1269.** A Simple Katharometer for Use with the Combustion Method.
STUVE, W.
Gas Chromatography 1958—Amsterdam Symposium—May 1958.
Ed. DESTY, D. H. Published by Butterworths 1958. 178-185. Discussion 185-188.
The main features of this katharometer are simplicity of construction and sufficient sensitivity. A small light bulb is used as measuring element, the glass envelope being removed before installation.
- 1270.** Chromatographic Determination of Sorbic Acid used as a Preservative in Beverages.
SUDARIO, E.
Chim. e ind. (Milan) **39** 811-814 (1957). *Chem. Abstr.* **52** 3251 (1958).
A new chromatographic method is described for the determination of sorbic acid.
- 1271.** Retention Volumes of Isomeric Hexenes and Hexanes in Gas-Liquid Partition Chromatography using Phthalate Esters as Liquid Phase.
SULLIVAN, L. J., LOTZ, J. R. and WILLINGHAM, C. B.
Anal. Chem. **28** (4) 495-498 (1956). *Chem. Abstr.* **50** 9822 (1956).
The retention volumes were determined on columns of Celite 545 impregnated with either didecyl phthalate or bis(tetrahydrofurfuryl) phthalate, using thermal conductivity detection with nitrogen as carrier gas.
- 1272.** Separation of Mercaptans by Gas-Liquid Partition Chromatography.
SUNNER, S., KARRMAN, K. J. and SUNDEN, V.
Mikrochim. Acta 1956 (7-8) 1144-1151. *Chem. Abstr.* **50** 8396 (1956).
In English. Lower mercaptans were separated on a column of carborundum impregnated with dioctyl phthalate containing 5% diphenylamine, and using oxygen-free nitrogen as carrier gas. The effluent gas was passed into a solution of iodine, potassium iodide and ethanol which constituted a Redox half element.
- 1273.** Analysis of Hydrocarbon Gases by the Chromatographic Method.
SVENTSITSKIL, E. I., LULOVA, N. I., TARASOV, A. I. and ZEMSKOVA, E. I.
Zavodskaya Lab. **22** (12) 1399-1403 (1956). *Chem. Abstr.* **51** 18561 (1957).
Describes the separation of C_1 - C_4 hydrocarbons on a column of silica gel. Air is used as desorbing medium, and the column can be heated by an electric furnace which can be made to move down the length of the column automatically.
- 1274.** Gas Chromatographic Detection of Small Amounts of Mixed Ethers in Ethylene.
SVERAK, J. and REISER, P. L.
Mikrochim. Acta 1958 (1) 159-168. *Chem. Abstr.* **53** 982 (1959).
The separation and detection of diethyl and dimethyl ethers was accomplished on a column of Sterchamol impregnated with 20% dimethylsulpholane at 25°C, using hydrogen as carrier gas and a differential thermal conductivity cell as detector.
- 1275.** Gas Chromatographic Determination of very small amounts of Carbon Disulphide in Carbon Dioxide and Inert Gases after Preliminary Enrichment.
SVERAK, J. and REISER, P. L.
Mikrochim. Acta 1958 (3) 426-433. *Anal. Abstr.* **5** 3660 (1958).

Carbon disulphide is concentrated by absorption on 'Blaugel' at 0°C in a preliminary enrichment stage and subsequently desorbed at 200°C before passing to a column packed with Sterchamol impregnated with dimethylsulpholane. Detection is by thermal conductivity. It is suggested that an enrichment stage could be advantageously incorporated in procedures for the determination of carbon disulphide.

1276. A New Synthesis of Fluoroketones.

SYKES, A., TATLOW, J. C. and THOMAS, C. R.

Chem. and Ind. (London) 1955 630-631.

Preparative scale gas chromatography was applied to the separation of small quantities of reaction products where fractionation was difficult.

1277. Principles of Chromatography.

SYNGE, R. L. M.

Proc. Intern. Wool Textile Research Conf., Melbourne, 1955B 238-248.
Chem. Abstr. **51** 17329 (1957).

A paper giving 27 references.

1278. Gas Chromatographic Separation of some Permanent Gases on Silica Gel at Reduced Temperatures.

SZULCZEWSKI, D. H. and HIGUCHI, T.

Anal. Chem. **29** (10) 1541-1543 (1957). *Chem. Abstr.* **52** 975 (1958).

Using silica gel as adsorbent at dry ice/acetone temperature, the separation of oxygen, nitrogen, nitric oxide and carbon monoxide was easily carried out. This separation cannot be effected at room temperature.

1279. Automatic Continuous Measurement of Minute Amounts of Gases by the Electric Conductivity Method.

TAKAHASHI, A.

Kagaku no Ryoiki **77** 783-788 (1953). *Chem. Abstr.* **48** 13536 (1954).

The determination of carbon dioxide, oxygen, carbon monoxide, ammonia, sulphur dioxide and hydrogen sulphide is described. 14 references are given.

1280. Gas Chromatography.

TAKAMIYA, N.

Shinku-Kogyo **5** 86-93 (1958). *Chem. Abstr.* **52** 18067 (1958).

A review covering the application of gas chromatography to the analysis of gases in metal materials.

1281. Apparatus made in Japan.

TAKAMIYA, N.

Kagaku no Ryoiki **12** 608-613 (1958). *Chem. Abstr.* **52** 19339 (1958).

A symposium lecture article. Only the title is listed in *Chem. Abstr.*

1282. Fisher-Gulf Partitioner.

TAKAYAMA, Y.

Kagaku no Ryoiki **12** 599-606 (1958). *Chem. Abstr.* **52** 19339 (1958).

A symposium lecture article. Only the title is listed in *Chem. Abstr.*

1283. Gas Chromatographic Analysis of Impurities in Commercial Methyl Acrylate.

TAKAYAMA, Y.

J. Chem. Soc. Japan, Ind. Chem. Sect. **61** (6) 682-684 (1958). *Anal. Abstr.* **5** 1840 (1959).

Using a column of Carbowax 400 and helium as carrier gas, methyl propionate and ethyl acrylate present as impurities in methyl acrylate may be determined. The column temperature was 83.5°C and methyl acetate was used as internal standard. For the determination of water vapour impurity, a column of tritolyl phosphate was used.

1284. Application of Gas Chromatography to Techno-Analytical Chemistry.

TAKEUCHI, T.

Kagaku no Ryoiki **12** 614-619 (1958). *Chem. Abstr.* **52** 19339 (1958).

A symposium lecture article. Only the title is listed in *Chem. Abstr.*

1285. Vapour-Phase Chromatography of Gaseous Hydrocarbons.

TARAMASSO, M.

Ricerca sci. **26** 887-888 (1956). *Chem. Abstr.* **50** 9944 (1956).

Ethane, propane, *n*- and *isobutane*, and *n*- and *isopentane* were separated on a column of diatomaceous earth impregnated with *n*-hexadecane at 25°C. Methane was used as carrier gas.

1286. Vapour-Phase Chromatographic Analysis of Saturated Gaseous Hydrocarbons.

TARAMASSO, M.

Termotecnica **10** 203-206 (1956). *Chem. Abstr.* **51** 2260 (1957).

The method used has been found to give reproducible results. If the gases to be separated are wet, there is a possibility of a relative displacement of the peaks. This has been investigated by adding small amounts of other gases to the carrier gas.

1287. Gas Chromatography as a Means of Indicating Atmospheric Pollution by Hydrocarbons.

TARAMASSO, M. and FARACI, R.

Minerva med. 1958 1054-1057. *Chem. Abstr.* **52** 12286 (1958).

A general discussion citing 6 references.

1288. Chromatography of Gases. Separation of Saturated and Corresponding Unsaturated Aliphatic Compounds.

TARAMASSO, M. and PICCININI, C.

Rass. chim. **9** (6) 10-12 (1957). *Chem. Abstr.* **52** 9857 (1958).

Mixtures of pentane/1-pentene/1-pentyne, propionaldehyde/acrolein, propyl and allyl bromides, methyl propionate/methyl acrylate, propyl, allyl and propargyl alcohols, and methyl butanol/methyl butenol/methyl butynol, were separated on columns of paraffin, polyethylene glycol 400, tritolyl phosphate and dioctyl phthalate at several temperatures from 25-110°C. The results obtained are reported and discussed.

1289. Chromatographic Analysis of Hydrocarbons.

TARBES, H. and BONNET, E.

J. usines gaz. **82** 261-266 (1958). *Chem. Abstr.* **52** 18094 (1958).

A discussion of apparatus, partition chromatography, and the analysis of easily liquefied hydrocarbon gases.

- 1290.** Application of Frequency-Response Analysis to the Measurement of the Thermal Conductivity of Gases.

TARMY, B. L.

Univ. Microfilms Publ. No. 20069, 218 pp. *Dissertation Abst.* **17** 1046 (1957). *Chem. Abstr.* **51** 11834 (1957).

Only the title is listed in *Chem. Abstr.*

- 1291.** Modern Analytical Techniques.

Chem. Age. **74** (1914) 633 (1956).

A very brief summary of a general lecture on gas chromatography given by Tatlow, J. C.

- 1292.** Fisher-Gulf Partitioner.

TAYLOR, B. W.

Presented at Pittsburgh Conf. on Anal. Chem. and Appl. Spectroscopy, February 1956.

Features of this apparatus include the use of columns up to 35 ft in length, a thermistor detector and a ball-and-disc integrator to record the area under the chromatograph peaks. The thermistor cell is placed just out of the flow stream and relies on diffusion. At a flow rate of 50 ml/min the response time is 2 seconds.

- 1293.** Development of Components of an Instrument for Research and Control Applications of Vapour-Phase Chromatography.

TAYLOR, B. W.

Presented at 129th National A.C.S. Meeting, Dallas, Texas, April 1956. Abstracts p. 17B No. 47.

Features of the developed instrument include a recording potentiometer with ball-and-disc continuous integrator, a sensitivity control to magnify the chromatogram of small traces of components and a specially designed thermistor type thermal conductivity cell. The columns are interchangeable. Examples of some separations are given.

- 1294.** Novel Use High Temperature Gas Chromatography Unit.

TAYLOR, B. W.

Chem. Age. **78** (1995) 563 (1957).

Describes an apparatus with a wide temperature range having high sensitivity and stability. It has independent thermal control of both column and thermal conductivity cell, and a modified sample injection system allows the rapid vapourisation of high boiling materials up to 400°C.

- 1295.** An Instrument Designed for High Temperature Gas Chromatographic Analysis.

TAYLOR, B. W.

Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.

Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958 155-164.

A full description of the apparatus which incorporates some novel features. The cell bath thermistor is regulated up to 200°C, and the column bath up to 300°C. A flash evaporator controlled up to almost 425°C is also included, and a new design of thermistor conductivity cell is used. Examples are given of the separation of methyl esters, phenyl benzene, isobutylene and butene-1, and benzene and chlorobenzene. Some stationary phases found fairly satisfactory at higher temperatures include Apiezon grease L, Stearone, polyethylene and D.C. Silicone High Vacuum grease.

- 1296.** The Analysis of Light Hydrocarbons by Gas-Liquid Chromatography. TAYLOR, G. W. and DUNLOP, A. S.
Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.
Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 73-84. Discussion 84-85.
The apparatus and method of analysis is fully described. 2 columns were used: a 12 ft dimethylformamide column at 0° for the analysis of C₄ hydrocarbons containing small quantities of C₃ and C₅ hydrocarbons, and a 6 ft dinonylphthalate column at 40° for the correction of propylene and C₅ interference. The use of the 2 separate columns is preferred to using a single combination column.
- 1297.** An Improved Hot Wire Cell for Accurate Measurements of Thermal Conductivities of Gases over a Wide Temperature Range. Results with Air between 87° and 375°K. TAYLOR, W. J. and JOHNSTON, H. L.
J. Chem. Phys. **14** (4) 219-233 (1946). *Chem. Abstr.* **40** 3951 (1946).
The cell is fully described and theoretical treatments discussed for radiation, end conduction, potential lead conduction, and the 'temperature jump' effect.
- 1298.** Gas-Partition Chromatography. Application to Essential Oils and Other Volatile Materials. TEITELBAUM, C. L.
Perfumery Essent. Oil Record **48** 88 (1957).
A review of a paper presented at a Meeting of the Society of Cosmetic Chemists. A general discussion of the application to essential oils and a report on preliminary work on the identity of citronellol and rhodinol. See also the following reference.
- 1299.** Gas-Partition Chromatography. Applications to Essential Oils and Other Volatile Materials. TEITELBAUM, C. L.
J. Soc. Cosmetic Chemists **8** 316-327 (1957). *Chem. Abstr.* **52** 662 (1958).
Chromatograms for mixtures of methyl, ethyl and isopropyl benzoates, and of C₁-C₁₀ aldehydes are shown. 2 samples of rhodinol are shown to consist largely of citronellol, but adulteration with commercial citronellol is detected by a side-peak on the main citronellol peak. Algerian and Reunion geranium oils are similar to each other, but very different from Turkish and synthetic geranium oils.
- 1300.** Basic Principles of Gas-Partition Chromatography. TEITELBAUM, C. L.
Am. Perfumer Aromat. **68** 19-21 (December 1956).
Gives a general description of the method.
- 1301.** The Selectivity of Various Liquid Substrates Used in Gas Chromatography. TENNEY, H. M.
Advances in Gas Chromatography—A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D-27 to D-41. (Presented during 132nd Meeting A.C.S.)
Eighteen different substrates were tested for selectivity towards hydrocarbons and oxygenated compounds. Of these materials, the dipropionitriles had the highest selectivity both for hydrocarbons and oxygenated compounds. See the following reference.

- 1302.** Selectivity of Various Liquid Substrates Used in Gas Chromatography.
TENNEY, H. M.
Anal. Chem. **30** (1) 2-8 (1958). *Chem. Abstr.* **52** 7936 (1958).
Eighteen stationary phases were investigated as to their selectivity towards hydrocarbons and oxygenated compounds in an apparatus using helium as carrier gas and a thermistor type thermal conductivity detector.
- 1303.** Sample Introduction System for Gas Chromatography.
TENNEY, H. M. and HARRIS, R. J.
Anal. Chem. **29** (2) 317-318 (1957). *Chem. Abstr.* **51** 6230 (1957).
The system described is positive and simple, and operates with high precision for both liquids and gases. The sample is measured in a capillary pipette having a handle which forms a pressure-tight seal with a neoprene O-ring. Samples from 1 μ l to 25 ml may be introduced.
- 1304.** Separation of Hydrocarbons by Elution Chromatography.
TENNEY, H. M. and STURGIS, F. E.
Anal. Chem. **26** (6) 946-953 (1954). *Chem. Abstr.* **48** 11246 (1954).
Is concerned with liquid chromatography, but is included here as a matter of interest. A full abstract may be found in *Chem. Abstr.*
- 1305.** Some Uses of Gas Chromatography in Petroleum Process Research.
TENNEY, H. M., McQUAID, F. S. and McQUAID, J. W.
Presented at Southwide Chem. Conf. on Instrumentation, Instr. Soc. Am. Symposium on Gas Chromatography, Memphis, Tennessee, December 1956.
No further details are available.
- 1306.** Determination of a Series of Malonic Esters by Gas Chromatography.
TEPE, J. B. and WESSELMAN, H. J.
J. Am. Pharm. Assoc. **47** 457-458 (1958). *Chem. Abstr.* **52** 13542 (1958).
The method used is described. No experimental details are given in *Chem. Abstr.*
- 1307.** Gas Chromatography. May Develop into Useful Process Analyser.
THOMAS, B. W.
Ind. Eng. Chem. **47** (6) 85A-88A (1955).
A general review of gas chromatography instrumentation. Some instruments available commercially in the U.S.A. are mentioned.
- 1308.** Separation of Hydrogen and Deuterium—Zone Refining of Mixtures of Ordinary and Heavy Water—Reaction of Iron with Mixtures of Ordinary and Heavy Water—Gas Chromatography with Hydrogen and Deuterium Samples.
THOMAS, C. O.
Univ. Microfilms L.C. Card No. Mic. 58-1327 215 pp. *Dissertation Abstr.* **18** 1279 (1958). *Chem. Abstr.* **52** 13364 (1958).
Only the title is listed in *Chem. Abstr.*
- 1309.** Chromatography: A Problem in Kinetics.
THOMAS, H. C.
Ann. N.Y. Acad. Sci. **49** 161-182 (1948). *Chem. Abstr.* **42** 5300 (1948).
A Langmuir-type isotherm results from a theory which is proposed and developed. An experimental investigation to test the theory is described.

- 1310.** The Identification of 3-Methylthiophene in Wilmington, California Crude Oil by Gas-Liquid Chromatography.
THOMPSON, C. J., COLEMAN, H. J., WARD, C. C. and RALL, H. T.
Presented at Southwest Regional Meeting, A.C.S. Local Sections, Tulsa, Oklahoma, December 1957.
No further details are available.
- 1311.** The Determination of Impurities in Carbon Dioxide by Gas Chromatography, with Special Reference to Coolant Gas for Nuclear Reactors.
TIMMS, D. G., KONRATH, H. J. and CHIRNSIDE, R. C.
Analyst **83** (1952) 600-609 (1958). *Chem. Abstr.* **53** 5961 (1959).
Using a 25 ml sample, impurities present at levels as low as 5-20 ppm can be determined on a 6 ft stainless steel column of Linde 5A molecular sieve, using hydrogen or argon as carrier gas, and a specially sensitive katharometer as detector. Full details (with some diagrams) of the apparatus are given.
- 1312.** Perkin-Elmer Model 154-C Vapour Fractometer. Explanation and Examples of Use.
TOMINAGA, S.
Kagaku no Ryoiki **12** 590-598 (1958). *Chem. Abstr.* **52** 19339 (1958).
A symposium lecture article. Only the title is listed in *Chem. Abstr.*
- 1313.** Gas-Liquid Chromatography.
TORRACA, G.
Chim. e ind. (Rome) 1957 (2/3) 2-19. *Chem. Abstr.* **52** 9714 (1958).
A review article containing 47 references.
- 1314.** Adsorption Theory of Gas Chromatography.
TOTH, J. and GRAF, L.
Magyar Kem. Folyoirat **63** 71-78 (1957). *Chem. Abstr.* **52** 13363 (1958).
In Hungarian with a German summary. An equation was developed to show the relationship between frontal and elution gas chromatography. More details are given in *Chem. Abstr.*
- 1315.** Determination of the Helium and Hydrogen Content of Natural Gases with Elution Chromatography.
TOTH, J. and GRAF, L.
Magyar Kem. Folyoirat **63** (8) 216-221 (1957). *Chem. Abstr.* **52** 10544 (1958).
Two columns of activated carbon (Nuxit-Al) were used, the first being operated at -60 to -70°C and the second at room temperature. Detection was by means of an interferometer or by thermal conductivity.
- 1316.** Combined Role of Solid, Carrier and Liquid in Gas-Liquid Chromatography.
TOTH, J. and GRAF, L.
Magyar Kem. Folyoirat **64** 85-92 (1958). *Chem. Abstr.* **52** 12495 (1958).
The equation developed in reference 1314 was found to apply also in gas-liquid chromatography if the difference between inlet and outlet pressures of the gas was low. Theoretical and experimental considerations on the relation of the 3 phases are described.
- 1317.** A Thermal Conductivity Method for the Determination of Isotopic Exchanges in the Simpler Gaseous Molecules.
TRENNER, N. R.
J. Chem. Phys. **5** (6) 382-392 (1937). *Chem. Abstr.* **31** 4855 (1937).

A simple high pressure thermal conductivity gauge of good mechanical stability, freedom from poisoning effects and high accuracy is described in detail. Its physical characteristics have been studied and optimum conditions for operation indicated. Its applicability to a wide variety of analyses is discussed. A correction to this article appeared in *J. Chem. Phys.* **5** (9) 751 (1937).

1318. Gas Chromatography.

TROTMAN-DICKENSON, A. F.

Penguin Science News **42** 41 (1956).

A general review of the subject.

1319. Gas Chromatography.

TROTMAN-DICKENSON, A. F.

The New Scientist No. 16, March 7, 1957 p. 27.

A short but very useful informative review written in a clear manner for semi-scientific consumption. Useful as an introduction to the subject.

1320. Process Control Methods in the Chlorination of Benzene.

TROUPE, R. A. and GOLNER, J. J.

Anal. Chem. **30** (1) 129-131 (1958). *Chem. Abstr.* **52** 5210 (1958).

Gas chromatography was used as the primary standard for the analysis of reaction mixtures of chlorinated benzenes by a method of density measurement.

1321. Sorting Molecules by Size and Shape.

TRUTER, E. V.

Research (London) **6** (8) 320-326 (1953). *Chem. Abstr.* **47** 11828 (1953).

A method of separating mixtures of chemical compounds is described which distinguishes itself by its simplicity and elegance. Complexes are formed of the mixture to be resolved and urea (or another reactant). The resultant molecules consist of a hollow cage-like structure, constituting one component, in which the other component is imprisoned. Thus molecules can be sorted according to size and shape. This could have applications in gas chromatography. By packing a column with urea, straight chain hydrocarbons, which form complexes, may be separated from branched chain hydrocarbons, which do not.

1322. Application of Gas Chromatography in the Petroleum Industry, Especially on the Analysis of Refinery Gas.

TSUDANO, S. and KIMURA, M.

Kagaku no Ryoiki **12** 620-626 (1958). *Chem. Abstr.* **52** 19339 (1958).

A symposium lecture article. Only the title is listed in *Chem. Abstr.*

1323. Gas Chromatography.

TUEY, G. A. P.

May and Baker Lab. Bull. **3** (1) 8 (1958).

A general descriptive article.

1324. Gas Chromatography and its Application to Perfumery Materials.

TUEY, G. A. P.

Soap, Perfum. Cosm. **31** (4) 353-361 (1958). *Anal. Abstr.* **5** 3415 (1958).

The principles of gas chromatography are discussed and its application to the analysis of essential oils described with the aid of examples.

1325. Chromatographic Titrimetric Gas Analyser.

TURKEL'TAUB, N. M.

Zavodskaya Lab. **15** 653-660 (1949). *Chem. Abstr.* **44** 9747 (1950).

A portion of the gas stream is oxidised over heated platinum wire to give the total hydrocarbon content. The other part is adsorbed on carbon and eluted by air with subsequent combustion to give methane, ethane, and the sum of higher hydrocarbons.

1326. Chromatographic Method of Separate Determination of Micro Concentrations of Hydrocarbons in Air.

TURKEL'TAUB, N. M.

Zhur. Anal. Khim. **5** (4) 200-210 (1950). *Chem. Abstr.* **44** 9856 (1950).

A chromatographic method was developed for separating micro-quantities of methane, ethane, propane, and heavier hydrocarbons from gas-air mixtures. A simple gas analyser is described.

1327. New Adsorption Methods of Analysis of Hydrocarbon Gases.

TURKEL'TAUB, N. M.

Neftyanoe Khoz. **32** (4) 72-77 (1954). *Chem. Abstr.* **48** 8517 (1954).

A chromathermographic procedure for hydrocarbon gas analysis is described (C_1 - C_4) which is applicable to small samples (5 ml). See the following reference.

1328. Chromathermographic Method of Analysis of Gases.

TURKEL'TAUB, N. M.

Trudy Komissii Anal. Khim., Akad. Nauk. S.S.S.R., Inst. Goekhim i Anal. Khim. **6** 146-161 (1955). *Chem. Abstr.* **50** 7663 (1956).

A mixture of C_1 - C_4 hydrocarbons was separated on a column of silica gel, detection being by means of an interferometer. More details are given in *Chem. Abstr.*

1329. Partition Chromatography Method for the Separation and Analysis of Hydrocarbon Gases.

TURKEL'TAUB, N. M.

Zhur. Fiz. Khim. **31** 2102-2108 (1957). *Chem. Abstr.* **52** 12675 (1958).

In Russian with an English summary. Gives a general description of gas-liquid partition chromatography, and describes the determination of the heats of solution of *n*- and isobutane, and *n*- and isopentane in petrolatum by partition chromatography.

1330. Use of a Mass Spectrometer for the Determination of the Resolving Capacity of a Chromathermographic Apparatus.

TURKEL'TAUB, N. M. and ABRAMOVICH, L. Y.

Zhur. Anal. Khim. **13** 43-47 (1958). *Chem. Abstr.* **52** 10795 (1958).

The purity of fractions separated by chromatography was checked by a mass spectrometer.

1331. Chromatographic Method of Analysis of Gases.

TURKEL'TAUB, N. M. and ZHUKHOVITSKII, A. A.

Zavodskaya Lab. **22** (9) 1032-1039 (1956). *Chem. Abstr.* **51** 17565 (1957).

A review of the method containing 51 references.

1332. Continuous Chromatography.

TURKEL'TAUB, N. M. and ZHUKHOVITSKII, A. A.

Geol. Nefti. **1** (2) 54-60 (1957). *Chem. Abstr.* **52** 3317 (1958).

A travelling heater is used to heat a 50 cm column of silica gel, and detection of the eluted fractions is by thermal conductivity. The separation of methane, ethane, propane, butane, pentane, hexane and heptane is described.

1333. Theory of Chromatographic Methods of Gas Analysis.

TURKEL'TAUB, N. M. and ZHUKHOVITSKII, A. A.

Zavodskaya Lab. **23** (9) 1023-1034 (1957). *Anal. Abstr.* **5** 1090 (1958).

A theoretical paper and a discussion, with examples, of the various important factors in this method of analysis.

1334. Chromathermographic Universal Apparatus for the Analysis of Complex Gaseous Mixtures.

TURKEL'TAUB, N. M. and ZHUKHOVITSKII, A. A.

Zavodskaya Lab. **23** (9) 1120-1124 (1957). *Anal. Abstr.* **5** 1743 (1958).

A description of the apparatus is given.

1335. Effect of Silica Gel Moisture Content on Chromatographic Separation of Gases.

TURKEL'TAUB, N. M., KOLYUBYAKINA, A. I. and SELENKINA, N. S.

Zhur. Anal. Khim. **12** 302-312 (1957). *Chem. Abstr.* **52** 1856 (1958).

Dry silica gel gave a poor separation of gases. Moistening the gel improved the separation greatly. The amount of moisture required varied with the kind of silica gel. An English translation of this article appears in *J. Anal. Chem. U.S.S.R.* **12** 311 (1957).

1336. Chromatographic Thermochemical Gas Analyser.

TURKEL'TAUB, N. M., PORSHNEVA, N. V. and KANCHEEVA, O. A.

Zavodskaya Lab. **22** (6) 735-738 (1956). *Chem. Abstr.* **51** 4774 (1957).

A portable apparatus which may be used in the field is described for the separation of hydrogen, carbon monoxide, methane, ethane, propane, butane and pentane.

1337. Separation of Hydrocarbon Mixtures by the Chromathermographic Method.

TURKEL'TAUB, N. M., SHVARTSMAN, V. P., GEORGIEVSKAYA, T. V., ZOLOTAREVA, O. V. and KARYMOVA, A. I.

Zhur. Fiz. Khim. **27** 1827-1836 (1953). *Chem. Abstr.* **48** 10476 (1954).

A theoretical description of chromatography. See also reference 1327.

1338. Chromatographic Method for Separation of Hydrogen, Carbon Monoxide, Methane and a Mixture of Rare Gases.

TURKEL'TAUB, N. M., ZOLOTAREVA, O. V., LATUKHOVA, A. G., KARYMOVA, A. I. and KALNINA, E.

Zhur. Anal. Khim. **11** 159-166 (1956). *Chem. Abstr.* **50** 14446 (1956).

Describes the separation of hydrogen, carbon monoxide and methane and also helium, neon, argon, krypton and xenon on columns of 3 kinds of coal. The preparation of the coal before packing into columns is described.

1339. A Robust but Sensitive Detector for Gas-Liquid Chromatography.

TURNER, D. W.

Nature **181** (4618) 1265-1266 (1958). *Chem. Abstr.* **53** 1 (1959).

The article describes a detector of change in dielectric constant of extreme simplicity, small sensitive volume, robustness and long linear range.

1340. The Synthesis of Radiochemically Labelled Fine Chemicals.

TURNER, H. S.

Lecture to Fine Chem. Group of Soc. Chem. Ind., London, January 1955. Reported in Chem. and Ind. (London) 1955 140.

The lecturer mentioned the use of vapour-phase chromatography as a means of separating similar compounds.

- 1341.** The Analysis of Hydrocarbon Gases by Means of Adsorption Fractionation.

TURNER, N. C.

Natl. Petroleum News **35** (18) R234-R237 (1943). *Chem. Abstr.* **37** 3914 (1943).

Hydrocarbons are separated on activated charcoal. A heater moves slowly up and down the column causing the hydrocarbons to move over the charcoal. The compounds are finally identified by thermal conductivity.

- 1342.** Development in Analysis of Hydrocarbon Gases by Adsorption Fractionation.

TURNER, N. C.

Oil Gas J. **41** (51) 48, 51, 52, 69 (1943). *Chem. Abstr.* **37** 6860 (1943). Essentially the same as the previous reference, but with more experimental details.

- 1343.** Developments in the Analysis of Hydrocarbon Gases by Means of Adsorption Fractionation.

TURNER, N. C.

Petroleum Refiner **22** (5) 140-144 (1943). *Chem. Abstr.* **37** 3914 (1943). See reference 1341.

- 1344.** The Chromatographic Determination of Ethylene in Coal Gas.

TUROWSKA, A. and JEDRZEJCZYK, B.

Gaz, Woda i Tech. Sanit. **31** 229-233 (1957). *Chem. Abstr.* **51** 18551 (1957).

Using a column (180 cm $\times$ 0.5 cm) of 'Alusil' zeolite, ethane, ethylene and acetylene could be determined in 4 ml samples of coal gas. Carbon dioxide was used as eluting gas.

- 1345.** Chromatographic Analysis of Coal Gas.

TUROWSKA, A. and JEDRZEJCZYK, B.

Gaz. Woda i Tech. Sanit. **31** 266-269 (1957). *Chem. Abstr.* **51** 18551 (1957).

See the previous reference. The complete analysis of coal gas is described.

- 1346.** The Estimation of Hydrogen Deuteride by Means of the Micro Thermal Conductivity Gauge.

TWIGG, G. H.

Trans. Faraday Soc. **33** (9) 1329-1333 (1937). *Chem. Abstr.* **31** 8264 (1937).

A high pressure micro thermal conductivity method is described. The composition calibration curve is not linear as would be expected from the theory of the gauge.

- 1347.** Theory of Thermal Separation of Gas Mixtures by the Adsorption Method.

VAGIN, E. V. and ZHUKHOVITSKII, A. A.

Doklady Akad. Nauk. S.S.S.R. **94** 273-276 (1954). *Chem. Abstr.* **50** 7540 (1956).

Assuming a constant pressure condition, the other variables involved in the separation of gas mixtures by adsorption in which a moving temperature gradient is employed, were analysed theoretically. The theory evolved was checked experimentally by the analysis of a mixture of helium and neon on activated carbon.

- 1348.** Complex Formation between Montmorillonite and the Phenols.
VARMA, M. C. P.
J. Indian Chem. Soc., Ind. and News Ed. **20** 11-16 (1957). *Chem. Abstr.* **52** 2674 (1958).
Complexes of montmorillonite with catechol, resorcinol, phenol and pyrogallol were studied using X-ray diffraction.
- 1349.** Gas-Liquid Chromatography of Synthetic Carboxylic Acids and the Alcohols Prepared from them.
VASILESCU, V.
Presented at Symposium on Gas Chromatography, Leipzig, October 1958. Preprints 236-248.
In German. In the control of a hydrogenation plant, carboxylic acid fractions and the alcohols obtained from them are analysed by gas chromatography.
- 1350.** A Laboratory Device for Checking the Purity of a Helium Stream.
VASIL'EV, D. I.
Pribory i Tekh. Eksperimenta 1958 (4) 107).
A simple thermal conductivity type apparatus is described which uses 2 reference elements of platinum wire (0.02 mm $\times$ 60 mm) coiled into a spiral (0.7 mm $\times$ 11-12 mm) and hermetically enclosed in glass bulbs filled with pure helium at atmospheric pressure. 2 other similar elements are placed in unsealed bulbs, and these are in the stream of gas to be analysed.
- 1351.** An Automatic Conductivity Bridge for Chromatographic Analysis.
VERDIER, C. H. de. and SJOBERG, C. I.
Acta. Chem. Scand. **8** 1161-1169 (1954). *Chem. Abstr.* **49** 8633 (1955).
In English. Describes an automatic bridge based on a conventional design which has been used extensively in conjunction with ion-exchange columns.
- 1352.** Analysis of Natural Gases: Methods and Applications.
VERRIEN, J. P.
Rev. Inst. franç. pétrole et Ann. combustibles liquides **11** (5) 641-683 (1956). *Chem. Abstr.* **50** 16076 (1956).
Only the title is listed in *Chem. Abstr.* Gas chromatography is mentioned as one method for the analysis of natural gases.
- 1353.** Selective Microdetermination of Alkoxy Groups by Gas-Liquid Chromatography.
VERTALIER, S. and MARTIN, F.
Chim. anal. **40** (3) 80-86 (1958). *Chem. Abstr.* **52** 8849 (1958).
The sample is treated with HI, and the liberated iodide absorbed in chloroform. A portion of the latter solution is chromatographed on a column of Celite impregnated with octyl phthalate at 70°C.
- 1354.** Column Partition Chromatography and its Application to the Separation of Fatty Acids.
VIOQUE, E.
Grasas y aceites **6** 88-93 (1955). *Chem. Abstr.* **50** 2191 (1956).
Essentially a review of the use of gas-phase and inverse-phase partition chromatography in the separation of fatty acids. 22 references are given.

1355. Gas Analysis by Thermal Conductivity Measurement.

VISSER, B. F.

Rec. trav. chim. **74** (5) 507-512 (1955). *Chem. Abstr.* **49** 16034 (1955).

In English. A description of the use of thermal conductivity measurements in metabolic studies.

1356. Apparatus for Gas Analysis by Gas Chromatography.

VLADIMIROV, B. V.

Neftyanoe Khoz. **34** (8) 61-64 (1956). *Chem. Abstr.* **51** 4061 (1957).

Describes the separation of hydrogen and hydrocarbons on a column of silica gel. Desorption is accomplished by heating the column and passing purified air.

1357. The Rapid Collection of Gas Samples for Analysis.

VOINOV, A. P.

Gazovaya Prom. 1958 (4) 48. *Chem. Abstr.* **52** 12368 (1958).

A schematic diagram is given illustrating the withdrawal of 4 or more samples from a pipeline. This is accomplished by means of an aspirator system.

1358. The Chromatography of Gases and Vapours.

VOSS, G. and HESSENAUER, F.

Erdol u Kohle **10** 161-163 (1957). *Chem. Abstr.* **51** 10177 (1957).

A general review with 18 references.

1359. Effects of Experimental Conditions on Chromatographic Separation in the Gas or Vapour Phases. I. The Temperature Effects on the Elution Separation of Methane, Ethane and Propane Mixture from Silica Gel.

VYAKHIREV, D. A. and BRUK, A. I.

Zhur. Fiz. Khim. **31** 1713-1720 (1957). *Chem. Abstr.* **52** 5929 (1958).

An English summary is given on p. 1720. Mixtures of methane, ethane and propane, and ethane with propane, were separated on silica gel columns using air as eluting gas and thermal conductivity detection.

1360. Volumetric-Chromatographic Method of Gas Analysis.

VYAKHIREV, D. A., BRUK, A. I. and GUGLINA, S. A.

Doklady Akad. Nauk. S.S.S.R. **90** 577-579 (1953). *Chem. Abstr.* **49** 13833 (1955).

Describes the separation of ethane/propane mixtures on columns of silica gel at 21.4°C, using carbon dioxide as carrier gas. A fuller abstract is given in *Chem. Abstr.*

1361. Chromatographic Analysis of Vapours and Gases.

WAKSMUNDZKI, A.

Wiadomosci chem. **11** 617-633 (1957). *Chem. Abstr.* **52** 9856 (1958).

A review of theory and methods of analysis containing 81 references.

1362. The Mass Spectrometer in Chemical Analysis.

WALDRON, J. D.

Metropolitan Vickers Gaz. **28** (456) 165-175 (1957). *Chem. Abstr.* **51** 16192 (1957).

Mass spectrometry may be used in conjunction with vapour-phase chromatography, and a table of comparisons between the 2 methods and infra-red is given. 40 references are appended.

- 1363.** Potentiometric Adsorption Analysis as Applied to Determination of Adsorption Isotherms of Chromatographic Adsorbents.
WALIGORA, B. and BYLO, Z.
Zeszyty Nauk. Univ. Jagiel., Ser. Nauk. Mat.-Przyrod., Mat., Fiz., Chem. No. 4 93-126 (1958). *Chem. Abstr.* **52** 17893 (1958).
An English summary is included. A review of chromatographic processes.
- 1364.** Precision Thermal Conductivity Gas Analyser Using Thermistors.
WALKER, R. E. and WESTENBERG, A. A.
Rev. Sci. Instr. **28** (10) 789-792 (1957). *Chem. Abstr.* **52** 7781 (1958).
The analyser, the characteristics of which are analysed theoretically, is precise, sensitive and of rugged construction. A full description is given.
- 1365.** Process Infra-red Analysers—1957.
WALL, R. F.
Ind. Eng. Chem. **49** (3) 69A (1957).
The limitations and advantages of gas chromatography in process analysis are discussed.
- 1366.** Process Control by Gas Chromatography.
WALL, R. F.
Ind. Eng. Chem. **50** (3) 51A (1958).
A review giving a general description and forecast that increased use will be made in 1958 of gas chromatography, especially in analytical control.
- 1367.** Process Analysis by Thermal Conductivity.
WALL, R. F.
Ind. Eng. Chem. **50** (5) 69A (1958).
A description of the design, characteristics and applications of thermal conductivity cells.
- 1368.** Gas-Liquid Partition Chromatography.
WALLACE, R. V.
Chem. Prods. **20** 116 (1957).
A general description of the use of gas chromatography for both qualitative and quantitative analysis which includes a short description of the apparatus used.
- 1369.** Gas Chromatography Analysis of the Crude Reaction Product from the Hydroformylation of Isobutene.
WARREN, G. W., HASKIN, J. F., KOUREY, R. E. and YARBOROUGH, V. A.
Advances in Gas Chromatography, A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D-131 to D-133. (Presented during 132nd Meeting, A.C.S.)
The crude reaction product was resolved on a 160 in. $\times$ 0.25 in. column of phenyl- α -naphthylamine on Celite 545 at 100°C with helium as carrier gas.
- 1370.** Sampling Apparatus.
WATSON, E. S. and BRESKY, D. R.
U.S. 2,757,541 (1956).
Describes a sampling apparatus which is a useful accessory to analysis systems where it is desired to draw a precisely reproducible volume of sample from one of several fluid streams and introduce that sample into another fluid stream. It should be especially useful in gas chromatography.

1371. Gas Analysis by Methods Depending on Thermal Conductivity.

WEAVER, E. R.

*In 'Physical Methods in Chemical Analysis'. Vol. II.**Ed. W. G. BERL. Published by Academic Press 1951. 387-437.*

An introduction describes the principles of the method, and the thermal conductivities of numerous substances are given. The effect of pressure and temperature on conductivity is discussed, and the conductivity of mixtures is dealt with. A complete description of the apparatus used and its method of operation is included.

1372. Determining Hydrogen in Gases with a Thermal Conductivity Apparatus.

WEBB, G. A. and BLACK, G. S.

Ind. Eng. Chem., Anal. Ed. 16 (11) 719-720 (1944). Chem. Abstr. 39 474 (1945).

A description is given of a Minter diffusion type thermal conductivity cell. It was used to evaluate the gaseous products from catalytic reactions.

1373. Fraction Cutter for Gas Chromatography.

WEINSTEIN, A.

Anal. Chem. 29 (12) 1899-1900 (1957). Chem. Abstr. 52 3417 (1958).

Describes an apparatus for collecting the separate components from a gas chromatographic column after separation. The separated fractions showed no trace of any other component when analysed on a mass spectrometer.

1374. Gas Chromatographic Determination of Impurities in Methyl Acrylate.

WEISS, A. R.

Presented at Symposium on Recent Developments in Research Methods and Instrumentation, Bethesda, Maryland, May 1956. Abstract in Anal. Chem. 28 (6) 1058 (1956).

A mixture of methyl acrylate containing small amounts of benzene, methyl propionate and ethyl acrylate could be separated on a 12 ft $\times$ 6 mm column containing ethylene carbonate as stationary phase. Acetone was used as an internal standard.

1375. Distillation.

WEITKAMP, A. W.

J. Am. Oil Chemists' Soc. 32 (11) 640-646 (1955). Chem. Abstr. 50 1338 (1956).

No details are given in *Chem. Abstr.* Discusses the theory of vapour-liquid equilibrium, and the height equivalent to a theoretical plate in packed columns. The paper mentions the application of these to gas chromatography.

1376. Analytical Separations in the Study of Limonene Sulphides.

WEITKAMP, A. W.

Presented at Symposium on Physico-Chemical Research on Flavour, Chicago, October 1957. Printed in Perfumery Essent. Oil Record 49 803-807 (1958).

The products from the reaction of sulphur with limonene were separated on a column of dinonyl phthalate on Celite, using nitrogen as carrier gas and a gas density balance detector. Details are also given of a 16 ft $\times$ 12 mm column for preparative work (ca 1 g).

1377. Fractional Permeation of Gases Through Membranes.

WELLER, S. and STEINER, W. A.

Chem. Eng. Progress **46** (11) 585-590 (1950). *Chem. Abstr.* **45** 394 (1951). Many membranes show widely varying permeabilities towards different gases, and this property can be made the basis of a process of gas separation. The theory of the process has been developed and checked experimentally, and it suggested that the separation of oxygen from air, helium from natural gas and hydrogen from coke oven gas, could be carried out in this way.

1378. Separation of Gases by Fractional Permeation through Membranes.

WELLER, S. and STEINER, W. A.

J. Appl. Phys. **21** (4) 279-283 (1950). *Chem. Abstr.* **44** 6216 (1950).

See the previous reference.

1379. Chromatographic Separation of Readily Volatile Gases.

WENCKE, K.

Chem. Tech. (Berlin) **8** (12) 728-730 (1956). *Chem. Abstr.* **51** 11930 (1957). Gas mixtures containing nitrogen, carbon monoxide, methane and carbon dioxide may be separated on a column of activated carbon using hydrogen as carrier gas and thermal conductivity detection.

1380. Chromatographic Method for Quantitative Gas Analysis.

WENCKE, K.

Chem. Tech. (Berlin) **9** 404-406 (1957). *Chem. Abstr.* **52** 155 (1958).

Describes the separation of nitrogen, oxygen, hydrogen, carbon monoxide, carbon dioxide and methane on a column (210 cm $\times$ 5 mm) of activated carbon at 20°C.

1381. A Gas Density Balance for Student Use.

WERNER, A. E.

J. Chem. Educ. **33** 393-395 (1956). *Chem. Abstr.* **51** 4784 (1957).

The construction of a gas density balance suitable for students is described, using only readily available materials.

1382. Determination of Deuterium, Oxygen and Nitrogen in Helium by Gas Chromatography.

WEST, D. L.

Presented at 2nd Conf. on Anal. Chem. in Nuclear Reactor Technol., Gatlinburg, Tennessee, September 1958.

No further details are available.

1383. The Sampling and Gas-Liquid Chromatographic Analysis of Organic Air Pollutants.

WEST, P. W., SEN, B. and GIBSON, N. A.

Advances in Gas Chromatography—A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D-51 to D-65. (Presented during 132nd Meeting, A.C.S.)

A method has been developed for the sampling and analysis of atmospheric organic pollutants. Sampling methods, the efficiency of various columns, effect of temperature and moisture are all discussed in detail. See the following reference.

1384. Gas-Liquid Chromatographic Analysis Applied to Air Pollution—Sampling.

WEST, P. W., SEN, B. and GIBSON, N. A.

Anal. Chem. **30** (8) 1390-1397 (1958). *Chem. Abstr.* **52** 18971 (1958).

Sampling methods are discussed, especially in relation to the effects of temperature on the sample obtained. The degree of resolution on different columns, the effect of moisture in the sample and other variable parameters are also considered.

1385. Changing Frontiers in the Analytical Chemistry of Paint Materials.
WHALLEY, C.

J. Oil Col. Chemists' Assoc. **39** (3) 193-208 (1956). *Chem. Abstr.* **51** 7736 (1957).

New methods of paint analysis are discussed. Chromatographic methods are included.

1386. The Thermal Conductivity of Associating Gases.

WHALLEY, E.

Discussions Faraday Soc. No. 22 54-63 (1956). *Chem. Abstr.* **51** 12583 (1957).

A gas which associates to dimers and trimers has critical properties. The thermal conductivity of such a gas has been calculated assuming that the diameter of the molecules is small compared with the mean free path and that inelastic collisions have negligible direct effect on the transport properties. Calculations have been compared with the thermal conductivity of real gases to try to obtain some insight into the mechanism of transport in dense gases.

1387. Determination of Hydrogen in Mine Airs Using a Gas Chromatographic Technique.

WHATMOUGH, P.

Nature **179** (4566) 911-912 (1957). *Chem. Abstr.* **51** 10963 (1957).

The determination is carried out on a column (7 ft $\times$ 3/16 in.) of activated carbon. An exactly similar column passing only reference gas serves to compensate for slight changes in inlet pressure. A twin-cell platinum wire katharometer is used as detector. Nitrogen is normally used as carrier gas, but if high sensitivity is required, argon is used instead.

1388. Gas Chromatograph as a Methanometer in the Coal Industry.

WHATMOUGH, P.

Nature **182** (4639) 863-864 (1958). *Chem. Abstr.* **53** 3795 (1959).

The apparatus used was as described in the previous reference. Peak areas varied linearly with concentration, but peak heights were only linear in the 0-5% and 45-100% range.

1389. Studies of Sebum. VII. The Composition of the Sebum of some Common Rodents.

WHEATLEY, V. R. and JAMES, A. T.

Biochem. J. **65** 36-42 (1957). *Chem. Abstr.* **51** 5231 (1957).

Gas chromatography was used to separate the methyl esters of fatty acids in the range C_{10} - C_{21} .

1390. Automatic Process-Stream Analysers.

WHERRY, T. C.

Oil Gas J. **54** (56) 125-126, 129 (1956). *Chem. Abstr.* **51** 4772 (1957).

A discussion of various types of process-stream analysers, in which vapour-phase chromatography is included as a probable new method.

- 1391.** Use of Organic-Montmorillonite Compounds in Gas Chromatography.
WHITE, D.
Nature **179** (4569) 1075-1076 (1957). *Chem. Abstr.* **51** 12598 (1957).
Sodium ions can be replaced by large organic cations such as amines and aromatic bases. Preliminary experiments carried out with a montmorillonite totally covered with the paraffinic chains of a quarternary ammonium compound showed a good separation of paraffins and aromatics.
- 1392.** The Sorption Properties of Dimethyldioctadecylammonium Bentonite Using Gas Chromatography.
WHITE, D. and COWAN, C. T.
Trans. Faraday Soc. **54** (4) 557-561 (1958). *Chem. Abstr.* **52** 19360 (1958).
Differences in the vapour-phase adsorption of aliphatic and aromatic compounds on the above substance have been investigated using gas chromatography.
- 1393.** Symmetrical Curves in Adsorption Chromatography.
WHITE, D. and COWAN, C. T.
Gas Chromatography 1958. *Amsterdam Symposium—May 1958.*
Ed. DESTY, D. H. Published by Butterworths 1958. 116-121. Discussion 122-124.
The possibility of obtaining symmetrical elution curves and constant retention volumes in gas-solid chromatography is examined from a thermodynamic point of view. An equation is given which relates the partition coefficient to the concentration, the heat of solution and the entropy of solution.
- 1394.** A Large Scale Analytical Gas-Liquid Partition Chromatographic Unit.
WHITHAM, B. T.
I. P. Symposium, London, 1956. 194-212.
Ed. DESTY, D. H. Published by Butterworths 1957.
Details of construction and operation are described. With a column 830 cm $\times$ 12.7 mm I.D. sample sizes of up to several ml of liquid have been separated. Some applications of this unit in the analysis of complex petroleum fractions and for preparative purposes are described.
- 1395.** Application of Gas-Liquid Partition Chromatography to Solvent Analysis.
WHITHAM, B. T.
I.P. Symposium, London, 1956. 395-412.
Ed. DESTY, D. H. Published by Butterworths 1957.
Procedures of identification and quantitative determination used in connection with solvent analysis when thermal conductivity is being used for detection are described. The importance of selective stationary phases is illustrated in the analysis of hydrocarbon solvents and mixtures of oxygenated compounds.
- 1396.** Use of Molecular Sieves in Gas Chromatography for the Determination of the Normal Paraffins in Petroleum Fractions.
WHITHAM, B. T.
Nature **182** (4632) 391-392 (1958). *Chem. Abstr.* **53** 4707 (1959).
Two columns are used. The pre-column is packed with Linde molecular sieve 5A coated with 1.6% by weight of squalane, and operated at 150°C. This column retains the *n*-paraffins. The main column is packed with Sil-o-cel firebrick impregnated with 26% by weight of E301 silicone grease,

and is operated at 164°C. One sample is passed through the main column only, and a second sample passed through both columns. The amount of each *n*-paraffin is obtained from the difference in the peak areas on the 2 chromatograms. Hydrogen was used as carrier gas with thermal conductivity detection.

- 1397.** Adsorption and Desorption Processes from a Gas Streaming over a Bed of Granular Adsorbent.

WICKE, E.

Kolloid-Z. **93** 129-157 (1940). *Chem. Abstr.* **35** 3872 (1941).

A detailed mathematical analysis of factors involved in the process in an attempt to explain the shape of the adsorption and desorption curves, as illustrated by the adsorption and desorption of carbon dioxide on activated carbon, using nitrogen as carrier gas.

- 1398.** The Separation of Gas Mixtures by Flow through Adsorbents.

WICKE, E.

Angew. Chem. **B19** 15-21 (1947). *Chem. Abstr.* **41** 4349 (1947).

Experimental data are reported for several gas mixtures. A propane/propylene mixture was separated by a single passage through an ignited bauxite column.

- 1399.** Purification of Helium-Group Gases.

WIDMANN, A. and BREUER, H.

Ger. 752,433 (1952). *Chem. Abstr.* **52** 2474 (1958).

Impurities may be absorbed from a mixture of the gases by passage over a sintered mixture of 10-75% Ce- or La-Al alloy and 90-25% Ti, Zr, Ta or Th.

- 1400.** Elution Time and Resolution in Vapour Chromatography.

WIEBE, A. K.

Presented at 129th Meeting, A.C.S., Dallas, Texas, April 1956. Abstracts p. 15B No. 39.

Some variables have been studied in order to determine the conditions necessary for maximum resolution with minimum elution time, and an equation has been derived relating these variables to the free energy. A definition of column efficiency has been suggested in which the resolving power is related directly with the partition coefficients for all compounds, and with the vapour pressures of similar compounds.

- 1401.** Elution Time and Resolution in Vapour Chromatography.

WIEBE, A. K.

J. Phys. Chem. **60** (5) 685-688 (1956). *Chem. Abstr.* **50** 12725 (1956).

Variable parameters affecting elution time and resolution were studied. These included carrier gas flow rate, column length and temperature. The experiments were carried out on mixtures of benzene, *n*-heptane, toluene, ethyl benzene and *p*-xylene, on a column of Celite impregnated with dioctyl phthalate, and using nitrogen as carrier gas with thermal conductivity detection.

- 1402.** Analytical Research in the Nobel Division of Imperial Chemical Industries.

WILLIAMS, A. F.

Proc. Congr. Modern Anal. Chem. in Industry. June 1957. Published by Heffers, Cambridge 1958. 144.

This article contains a section on the separation of silanes by gas chromatography.

1403. Analysis by Vapour-Phase Chromatography above 150°C.

WILLIAMS, E. F.

Presented at 129th National A.C.S. Meeting, Dallas, Texas, April 1956. Abstracts p. 15B No. 41.

An account of the apparatus used, and the development of new liquid stationary phases for operation at high temperatures. The inert supports used were the conventional ones, Celite, firebrick etc.

1404. Gas Chromatography—Complementary to Spectroscopy.

WILLIAMS, E. F.

Presented at 11th Ann. Meeting of Soc. for Appl. Spectroscopy, New York, November 1956. Abstract in Appl. Spectroscopy 10 221 (1956).

A description of the separation of components by gas chromatography and their detection and identification by spectroscopic methods.

1405. Two Physical Methods for the Determination of One Component of a Mixture of Gases.

WILLIAMS, M. D., BROWN, H. O., DUBLIN, W. B. and BOOTHBY, W. M.

Proc. Minn. Acad. Sci. 13 46-53 (1945). Chem. Abstr. 45 9310 (1951).

A sonic method is described by which helium and oxygen may be determined in helium/oxygen/nitrogen mixtures.

1406. Gradient Elution Analysis.

WILLIAMS, R. J. P.

Analyst 77 (921) 905-914 (1952). Chem. Abstr. 47 1530 (1953).

Some limitations of current chromatographic procedures are discussed and the suggestion is made that gradient elution analysis overcomes a number of them, although it has certain disadvantages.

1407. General Principles of Chromatography.

WILLIAMS, R. J. P.

Brit. Med. Bull. 10 (3) 165-169 (1954). Chem. Abstr. 49 9428 (1955).

Discusses early experiments, partition chromatography and elution analysis, frontal and displacement analysis, carrier displacement and gradient elution analysis. 20 references are given.

1408. Radiolysis of Tributyl Phosphate.

WILLIAMS, T. F., WILKINSON, R. W. and RIGG, T.

Nature 179 540 (1957). Chem. Abstr. 51 12670 (1957).

Irradiated tributyl phosphate saturated with water was analysed using a Griffin vapour-phase chromatography apparatus. The chromatogram was compared with one from a non-irradiated sample spiked with 5% *n*-butanol and 5% *n*-butylaldehyde.

1409. Separation of Natural Gas.

WILLIAMS, V. C.

U.S. 2,713,780 (1955). Chem. Abstr. 49 14301 (1955).

Describes a reversible rectification process.

1410. A Sensitive Versatile Acoustic Gas Analyser Particularly Suitable for the Analysis of Anaesthetic Mixtures.

WILSON, J. E.

Rev. Sci. Instr. 25 (9) 927-928 (1954). Chem. Abstr. 49 7893 (1955).

The instrument is described fully.

1411. A Theory of Chromatography.

WILSON, J. N.

J. Am. Chem. Soc. **62** 1583-1591 (1940). *Chem. Abstr.* **34** 5369 (1940).

This theory has been developed assuming that an instantaneous equilibrium is established between solution and adsorbent, and also that diffusion effects may be neglected. A discussion is also included of factors which make agreement between theoretical and experimental results unlikely.

1412. Isotope Effects in Gas-Liquid Chromatography.

WILZBACH, K. E. and RIESZ, P.

Science **126** 748-749 (1957). *Chem. Abstr.* **52** 1725 (1958).

The substitution of deuterium or tritium in organic compounds causes considerable changes in the retention volumes of those compounds. Experiments are described for the β -irradiation of benzene. A correction to this paper was published in *Science* **126** 1062 (1957).

1413. Qualitative and Quantitative Micro-Gas-Analysis by the Desorption-Heat-Conductivity Method.

WIRTH, H.

Mikrochemie ver. Mikrochim. Acta **40** 15-20 (1952). *Chem. Abstr.* **47** 993 (1953).

The method described utilises a gas sample of only 0.01-0.001 ml. Fractions are desorbed from the adsorbent and pumped off. The thermal conductivity of each sample is measured.

1414. The Separation of Gases by Sorption Processes. I.

WIRTH, H.

Monatsh. **84** 156-168 (1953). *Chem. Abstr.* **47** 7285 (1953).

The principles of adsorption-desorption processes are given, and the separation of the following mixtures is described:—nitrogen/carbon monoxide, nitrogen/methane, methane/carbon monoxide, ethylene/carbon dioxide, methane/ethane and ethane/propane. The separations were carried out on activated carbon.

1415. Separation of Gases by Sorption Processes. II.

WIRTH, H.

Monatsh. **84** 741-750 (1953). *Chem. Abstr.* **48** 2440 (1954).

See the previous reference. The following mixtures were separated on columns of silica gel:—nitrogen/oxygen, nitrogen/argon, nitrogen/methane, nitrogen/carbon monoxide, carbon monoxide/methane and oxygen/argon. The separation of mixtures of nitrogen/oxygen and ethane/ethylene/acetylene/carbon dioxide was discussed fully. The paper also includes a description of a vacuum apparatus for handling gases.

1416. The Analytical Separation of Ethane, Ethylene and Acetylene by Fractional Bromination on Activated Carbon.

WIRTH, H.

Monatsh. **84** 751-753 (1953). *Chem. Abstr.* **48** 2522 (1954).

The gaseous mixture is passed over freshly prepared charcoal containing adsorbed bromine. Below -78°C only ethylene reacts with the bromine to form $\text{C}_2\text{H}_4\text{Br}_2$. Acetylene reacts forming $\text{C}_2\text{H}_2\text{Br}_4$ at 0°C , and if the temperature is kept below 20°C , ethane does not react at all. By suitable variations in temperature, the 3 components may be determined by measuring the decrease in sample volume.

- 1417.** The Hydrogen Microflame Detector using Nitrogen as a Carrier Gas.
WIRTH, M. M.
I.P. Symposium, London, 1956. 154-168.
Ed. DESTY, D. H. Published by Butterworths 1957.
Using hydrogen as carrier gas, it was not possible to obtain a straight base line because of the high diffusivity of hydrogen. Thus nitrogen was used as carrier, the column effluent being injected into a constant hydrogen stream and burnt at the tip of a capillary. Full constructional and operating details are given.
- 1418.** Gas Chromatography. The Effects of some of the Variables Encountered in the Elution Technique and some Applications of the Displacement Technique.
WISE, K. V. and OLIVER, G. D.
Presented at Conf. on Anal. Chem. and Appl. Spectroscopy, Pittsburgh, February 1956.
See the next reference.
- 1419.** Gas Chromatography. Effects of some of the Variables Encountered in the Elution Technique and some Applications of the Displacement Technique.
WISE, K. V. and OLIVER, G. D.
Presented at 129th National A.C.S. Meeting, Dallas, Texas, April 1956. Abstracts p. 16B No. 44.
Using helium and nitrogen as carrier gases, and a column packed with activated carbon, elution chromatograms of oxygen and methane were developed to determine the effects of (a) column temperature, (b) carrier gas flow rate and (c) pressure gradient across the column, on the speed of development. Using dimethyl ether as carrier gas with the displacement technique, pure gases were obtained for mass spectrometer calibration.
- 1420.** The Use of Helium as the Mobile Phase in Gas Chromatography.
WISEMAN, W. A.
Chem. and Ind. (London) 1956 (7) 127-129. Chem. Abstr. 50 9204 (1956).
A discussion on the use of helium with experimental illustrations. The detector was a glass katharometer or a gas density balance, and separations of isoamyl alcohol, ethyl acetate, and isobutyl alcohol were studied using nitrogen and helium as carrier gases. Helium offers greater sensitivity than nitrogen especially at higher temperatures, but gives broader peaks and less resolving power.
- 1421.** Behaviour of Katharometers.
WISEMAN, W. A.
Chem. and Ind. (London) 1957 (41) 1356-1357. Chem. Abstr. 52 2461 (1958).
It has been generally assumed that response is proportional to the temperature differential between the wire and the walls. This is not true in ideal conditions and it has been shown, (experimentally and theoretically), that the response is proportional to the temperature differential ($^{\circ}\text{C}$) raised to the power $3/2$.
- 1422.** Gas Chromatography and the Perfumer.
WISEMAN, W. A.
Perfumery Essent. Oil Record 48 (8) 380-385 (1957). Chem. Abstr. 52 3269 (1958).

A general review of gas chromatography. Chromatograms are given for linalyl acetate, lavender oil and Rose oil.

1423. Water Absorption by Active Alumina.

WOHLLEBEN, G.

J. Chromatog. **1** (3) 271-273 (1958). *Chem. Abstr.* **52** 18077 (1958).

In German with an English summary. Storage of alumina has no influence on its behaviour in chromatography, but a minimum storage time of 2 hours should be allowed after addition of the required amount of water for deactivation.

1424. Radioassay by Gas Chromatography of Tritium- and C¹⁴-labelled compounds.

WOLFGANG, R. and ROWLAND, F. S.

Anal. Chem. **30** (5) 903-906 (1958). *Chem. Abstr.* **52** 13519 (1958).

The emerging helium stream is injected with methane, and the mixed gases passed through an internal proportional counter of special design. A radioactivity profile is recorded on a chart.

1425. Microchemical Techniques and Methods Applied to Problems in the Coal Industry.

WOOD, J. H.

Presented at 15th Intern. Congr. of Pure and Appl. Chem., Lisbon, September 1956.

The paper refers to the determination of hydrogen by gas chromatography, but no further details are available.

1426. Good Use of Process Analysers.

WREYFORD, D. M. and RICHEY, N.

Oil Gas J. **56** 76-78, 81-82, 84-85 (June 30, 1958). *Chem. Abstr.* **52** 21024 (1958).

Describes the use of 2 gas chromatographs for process stream analysis. Full details of the installation are given.

1427. A Gas Introducer for a Vacuum System.

WYLLIE, H. A.

J. Sci. Instr. **33** (9) 360-361 (1956). *Chem. Abstr.* **51** 3197 (1957).

Describes a compact glass apparatus for introducing small, measured volumes of gas into a vacuum system.

1428. The Use of Frontal Analysis in the Gas-Liquid Chromatography of Radioactive and Nonradioactive Gases.

YANOVSKII, M. I. and GAZIEV, G. A.

Doklady Akad. Nauk. S.S.S.R. **120** (4) 812-814 (1958). *Chem. Abstr.* **53** 11099 (1959).

An 8-component gas mixture was analysed and the radioactivity of the separated fractions was determined.

1429. Determination of Small Amounts of Acetylene in Air with Silica Gel Treated with Liquid Oxygen.

YASUI, E. and SUZUKI, H.

J. Chem. Soc. Japan, Ind. Chem. Sect. **61** (2) 176-179 (1958). *Anal. Abstr.* **5** 4326 (1958).

Other impurities such as sulphur dioxide, nitrogen peroxide, methane, carbon dioxide and ammonia are first removed by bubbling the sample through concentrated sulphuric acid and then pyrogallol. The gas is then dehydrated and passed into silica gel immersed in liquid oxygen. The acetylene is finally reacted with Ilosvay reagent.

- 1430.** Separation of the Products of Cool Flame Oxidation of Propane.
YOKLEY, C. R. and FERGUSON, R. E.
Combustion and Flame **2** 117-128 (1958). *Chem. Abstr.* **52** 14131 (1958).
Gas chromatography and low pressure distillation were used to separate the products.
- 1431.** Liquid-Phase Mass Transfer Rates and Effective Interfacial Area in Packed Adsorption Columns.
YOSHIDA, F. and KOYANAGI, T.
Ind. Eng. Chem. **50** 365-374 (1958). *Chem. Abstr.* **52** 10654 (1958).
Describes studies on the adsorption of carbon dioxide by water and by methanol in packed columns of various materials.
- 1432.** A Doser for Admitting Measured Amounts of Vapour.
YOUNG, D. M.
Rev. Sci. Instr. **24** (1) 77 (1953).
This note describes how the usual doser technique may be modified to permit the handling of vapours.
- 1433.** A Derivation of the Equation for Elution Chromatography Assuming Linear Rate Constants.
YOUNG, J. F.
Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.
Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958 15-23.
A theoretical and mathematical treatment aimed at defining concisely empirical coefficients in terms of the usual gas chromatography parameters.
- 1434.** Theoretical Prediction of Resolution in a Gas Chromatography Column.
YOUNG, J. F.
Presented at 133rd Meeting A.C.S., San Francisco, April 1958. Abstracts p. 48B No. 128.
An equation was developed for changes of resolution with flow rate, assuming that only 2 factors affect the spread of an elution curve:—(1) the resistance to adsorption into the stationary liquid and (2) the diffusion while in the gas phase. Data for *isobutane* are given to show conformance to the equation, the general form of which is similar to that of van Deemter, but the assignment of reasons for each term is considerably different.
- 1435.** The 'Family Plot' of Retention Volumes for Alkyl Ketones on Dinonyl Phthalate.
YOUNG, J. R.
Chem. and Ind. (London) 1958 (20) 594-595. *Chem. Abstr.* **53** 810 (1959).
The article gives and discusses chromatographic data for 15 dialkyl ketones on dinonyl phthalate in the temperature range 60-100°C. A very full abstract is given in *Chem. Abstr.*
- 1436.** The Thermal Decomposition of Ketene.
YOUNG, J. R.
J. Chem. Soc. 1958 2909-2921. *Chem. Abstr.* **52** 19362 (1958).
Three columns were used in this work. Activated charcoal at 70°C was used to separate carbon monoxide and methane, the same material at 160°C to separate carbon dioxide, carbon monoxide, etc., and a column of Celite 505 impregnated with dinonyl phthalate which gave a separation of all the reaction products. A very full abstract is given in *Chem. Abstr.*

- 1437.** Analysis of Dissolved Hydrocarbon Gases in Gasoline by Combined Adsorption and Gas-Liquid Partition Chromatography.
YU, W-L.

Jan. Liao Hsueh Pao **2** 352-354 (1957). *Chem. Abstr.* **52** 8519 (1958).

A column of firebrick impregnated with dibutyl phthalate was used to separate hydrocarbon fractions below C_4 from those above C_5 . The separated fractions were resolved further by adsorption on fullers earth.

- 1438.** The Adsorption of Normal Paraffins on Cracking Catalysts.

ZABOR, R. C. and EMMETT, P. H.

J. Am. Chem. Soc. **73** 5639-5643 (1951). *Chem. Abstr.* **46** 2786 (1952).

A silica-alumina cracking catalyst was used for experiments on the adsorption of butane, heptane and octane from 40-530°C.

- 1439.** The Chromatographic Method of Gas Analysis and its Industrial Uses.
ZAWISZA, A.

Koks, Smola, Gaz. **2** 157-165 (1957). *Chem. Abstr.* **52** 2652 (1958).

An English summary is included. Describes the principles, methods and apparatus for use in chromatographic analysis.

- 1440.** The Stereochemistry of Raney Nickel Action. VIII. Carbon-Carbon Bond Hydrogenolyses Catalysed by Raney Nickel.

ZDERIC, J. A. BONNER, W. A. and GREENLEE, T. W.

J. Am. Chem. Soc. **79** (7) 1696-1698 (1957). *Chem. Abstr.* **51** 11296 (1957).

The reaction products were separated by gas chromatography on a column (4 ft x $\frac{1}{2}$ in.) of Celite impregnated with silicone. The carrier gas was helium and detection was by means of a tungsten lamp filament. The compounds were identified by infra-red spectroscopy.

- 1441.** Chromatographic Analysis of Mixtures of C_5 Hydrocarbons.

ZHUKHOVITSKII, A. A., KASANSKY, B. A., STERLIGOV, O. D. and TURKEL'TAUB, N. M.

Doklady Akad. Nauk. S.S.S.R. **123** (6) 1037-1040 (1958).

Two columns were used. An alumina column was operated with a temperature gradient of 20-120°C. A column of kieselguhr impregnated with dinonyl phthalate was kept at a temperature constant to 1°C. Dried, purified air was used as carrier gas, and a thermal conductivity detector was supplemented with heat of combustion measurements for very small amounts of substances.

- 1442.** Adsorption Spectrum Analysis.

ZHUKHOVITSKII, A. A. and TURKEL'TAUB, N. M.

Doklady Akad. Nauk. S.S.S.R. **94** (1) 77-80 (1954). *Anal. Abstr.* **1** 2323 (1954).

The movement of a heater along an adsorption column causes the width of any adsorbed band of a single substance to vary with time. Equations are derived to explain this.

- 1443.** Separation of Gaseous Mixtures.

ZHUKHOVITSKII, A. A. and TURKEL'TAUB, N. M.

U.S.S.R. 103,041 (1956). *Chem. Abstr.* **52** 5057 (1958).

The components of a gaseous mixture can be separated by changing the temperature of the adsorbent, either by moving a heater through the stationary adsorbent or by moving the adsorbent through a stationary heater. See also reference 1446.

1444. Apparatus for the Continuous Analysis of Gases.

ZHUKHOVITSKII, A. A. and TURKEL'TAUB, N. M.

Zavodskaya Lab. **22** 1252-1255 (1956). *Chem. Abstr.* **51** 13471 (1957).

The analysis of a mixture of propane, butane, isopentane and hexane is described using a new apparatus.

1445. Chromathermographic Method of Separation and Analysis of Gases.

ZHUKHOVITSKII, A. A. and TURKEL'TAUB, N. M.

Uspekhi Khim. **25** 859-871 (1956). *Chem. Abstr.* **50** 15324 (1956).

This paper is a review of adsorption chromatography on silica gel. 41 references are included.

1446. Apparatus for Continuous Separation of Gaseous Mixtures.

ZHUKHOVITSKII, A. A. and TURKEL'TAUB, N. M.

U.S.S.R. 107,842 (1957). *Chem. Abstr.* **52** 5898 (1958).

See also reference 1443. The adsorption column is constructed in the form of a horizontal open circle.

1447. Thermal Factors in Adsorption Methods of Separation of Mixtures.

ZHUKHOVITSKII, A. A. and TURKEL'TAUB, N. M.

Uspekhi Khim. **26** 992-1006 (1957). *Chem. Abstr.* **52** 4383 (1958).

Discusses the theory of thermal chromatography with a review of the literature. 32 references are given.

1448. Use of the Thermal Factor in Gas Chromatography.

ZHUKHOVITSKII, A. A. and TURKEL'TAUB, N. M.

Doklady Akad. Nauk. S.S.S.R. **116** 986-989 (1957). *Chem. Abstr.* **52** 17892 (1958).

Describes the separation of methane, ethane, propane, butane, pentane and hexane on a column having a temperature gradient of 20-100°C.

1449. Continuous Chromathermography.

ZHUKHOVITSKII, A. A., TURKEL'TAUB, N. M. and GEORGIEVS-KAYA, T. V.

Doklady Akad. Nauk. S.S.S.R. **92** (5) 987-990 (1953).

Describes the analysis of a mixture of gases on a column of silica gel having a temperature gradient. The exit gas is analysed by means of an interferometer. The article also includes a mathematical treatment of the process.

1450. The Theory of Chromathermography.

ZHUKHOVITSKII, A. A., TURKEL'TAUB, N. M. and SHVARTSMAN, V. P.

Zhur. Fiz. Khim. **28** 1901-1909 (1954). *Chem. Abstr.* **50** 7541 (1956).

The causes of diffuse band formation were studied, and the experimental evidence showed that the principal cause of this was longitudinal diffusion.

1451. Theory of Chromathermography.

ZHUKHOVITSKII, A. A., TURKEL'TAUB, N. M. and SOKOLOV, V. A.

Doklady Akad. Nauk. S.S.S.R. **88** 859-862 (1953). *Chem. Abstr.* **47** 11882 (1953).

This article consists of a mathematical treatment of the process. See also reference 1449.

- 1452.** The Spreading of Bands During Chromathermographic and Thermal Separation.
ZHUKHOVITSKII, A. A., TURKEL'TAUB, N. M., VAGIN, E. V. and SHVARTSMAN, V. P.
Doklady Akad. Nauk. S.S.S.R. **96** 303 (1954).
The spreading of bands limits methods of separation of gas mixtures by adsorption. The problem is analysed mathematically, and the effect of diffusion is considered. An equation was developed to describe the concentration distribution in a band.
- 1453.** New Method of Chromatographic Analysis.
ZHUKHOVITSKII, A. A., ZOLOTAREVA, O. V., SOKOLOV, V. A. and TURKEL'TAUB, N. M.
Doklady Akad. Nauk. S.S.S.R. **77** 435-438 (1951). *Chem. Abstr.* **46** 11011 (1952).
A description of the chromathermographic method. A fuller abstract is given in *Chem. Abstr.*
- 1454.** The Thermal Conductivity of Nitrogen and Argon in the Liquid and Gaseous States.
ZIEBLAND, H. and BURTON, J. T. A.
Brit. J. Appl. Phys. **9** (2) 52-59 (1958). *Chem. Abstr.* **52** 10704 (1958).
The apparatus used was of the vertical coaxial cylinder type, and measurements were made in the range 85-200°K and between 1 and 135 atmospheres. The critical region was covered in both cases.
- 1455.** Molecular Sieves.
ZIEGENHAIN, W. C.
Petrol. Engr. **29** (9) C6-C12 (1957). *Chem. Abstr.* **51** 15103 (1957).
Describes the use of synthetic zeolites for the selective adsorption of *n*-paraffins.
- 1456.** Separation of Helium-Neon-Nitrogen Mixtures by a Combined Method of Adsorption and Desorption.
ZIELINSKI, E.
Przemysl. Chem. **13** 642-646 (1957). *Chem. Abstr.* **52** 6860 (1958).
The mixed gases were adsorbed on activated carbon at liquid air temperature. Desorption was carried out under vacuum. An English summary is given.
- 1457.** Exploratory Process Gas Chromatography.
ZINN, T. L., BAKER, W. J., NORLIN, H. L. and WALL, R. F.
Gas Chromatography—Instr. Soc. Am. Symposium—August 1957.
Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press 1958. 281-285.
A full description, with discussion, of the instrument and design parameters for its components, and also details of experience gained in its use and application.
- 1458.** The Resolution of Isomeric Hexanes by Gas-Liquid Chromatography.
ZLATKIS, A.
Advances in Gas Chromatography, A.C.S. Symposium—New York, September 1957. Published by A.C.S. 1957. D-127 to D-129. (Presented during 132nd Meeting, A.C.S.)
The isomeric hexanes may be resolved on a column of brucine/quinoline on Celite 44860 (or C22 firebrick) at 0°C, using helium as carrier gas and thermal conductivity detection. See the following abstract.

- 1459.** Resolution of Isomeric Hexanes by Gas-Liquid Chromatography.
ZLATKIS, A.

Anal. Chem. **30** 332-333 (1958). *Chem. Abstr.* **52** 10808 (1958).

The column used (250 cm $\times$ 5 mm) was packed with either *isoquinoline* on Celite for the separation of 2,3-dimethylbutane and 2-methylpentane, or quinoline/brucine (7 : 1) for the separation of alkanes and naphthenes. Other details are as in the previous reference.

- 1460.** A New Approach to Amino Acid Analysis.

ZLATKIS, A. and ORO, J. F.

Presented at 133rd Meeting A.C.S., San Francisco, April 1958. Abstracts p. 13C No. 29.

A rapid method is described for converting amino acids to volatile compounds and the separation and analysis of the latter by gas chromatography. See the next abstract.

- 1461.** Amino Acid Analysis by Reactor-Gas Chromatography.

ZLATKIS, A. and ORO, J. F.

Anal. Chem. **30** (6) 1156 (1958). *Chem. Abstr.* **52** 15345 (1958).

Amino acids are oxidised to volatile aldehydes in a micro reactor containing ninhydrin on diatomaceous earth. The resulting aldehydes are separated on a column of Celite impregnated with silicone oil.

- 1462.** A Methane-Conversion Detector for Gas Chromatography.

ZLATKIS, A. and RIDGWAY, J. A.

Nature **182** (4628) 130-131 (1958). *Anal. Abstr.* **6** 1981 (1959).

Using hydrogen as carrier gas, the eluted components are converted to methane and water by passing them through a tube of hydrocracking nickel catalyst. After removal of water, the methane is detected by thermal conductivity. Advantages of this method of detection are given.

- 1463.** Gas Chromatographic Separation of *m*- and *p*-Xylenes in Aromatic Mixtures.

ZLATKIS, A., O'BRIEN, L. and SCHOLLY, P. R.

Nature **181** (4626) 1794 (1958). *Chem. Abstr.* **52** 20995 (1958).

Benzene, toluene, ethylbenzene, *o*-xylene, *m*-xylene and *p*-xylene were separated on a column (5 m $\times$ 5 mm) of Chromosorb impregnated with 15% benzylidiphenyl and operated at 100°C. Helium was used as carrier gas, and the time of analysis was 93 minutes. A chromatogram is shown for the separation.

- 1464.** Automatic Recording of Gas-Chromatographic Analyses.

ZMITKO, J., BRODSKY, J. and BIZA, V.

Chem. Prumysl. **7** 414-416 (1957).

In Czech. with an English summary. See the following reference.

- 1465.** Automatic Recording of Gas Chromatographic Analyses.

ZMITKO, J., BRODSKY, J. and BIZA, V.

Chem. Tech. (Berlin) **9** (8) 458-459 (1957). *Chem. Abstr.* **52** 7788 (1958).

The method described uses an automatic recording meter coupled to a thermal conductivity cell. Hydrogen is used as carrier gas.

- 1466.** Vapour-Phase Chromatography.

Ed. DESTY, D. H. Published by Butterworths 1957.

Contains a complete account of the papers presented and discussions which took place at the Symposium sponsored by the Hydrocarbon Research Group of the Institute of Petroleum, and held at the Institution of Electrical

Engineers, London on 30th May-1st June, 1956. The papers presented will be found under the names of the first authors. See references 3, 183, 193, 230, 327, 333, 338, 371, 410, 471, 515, 541, 546, 593, 599, 609, 619, 636, 695, 730, 731, 797, 807, 916, 947, 962, 996, 1096, 1113, 1149, 1166, 1199, 1394, 1395 and 1417.

1467. Gas Chromatography 1958.

Ed. DESTY, D. H. Published by Butterworths 1958.

Contains a complete account of the papers presented and the discussions which took place at the second symposium organised by the Gas Chromatography Discussion Group under the auspices of the Hydrocarbon Research Group of the Institute of Petroleum and the Koninklijke Nederlandse Chemische Vereniging held at the Royal Tropical Institute, Amsterdam, 19-23 May, 1958. The papers presented will be found under the names of the first authors. See references 4, 17, 69, 134, 188, 192, 194, 281, 317, 354, 372, 389, 434, 436, 513, 529, 539, 558, 570, 594, 651, 735, 847, 878, 897, 908, 931, 950, 1108, 1202, 1269 and 1393.

1468. Gas Chromatography.

Ed. COATES, V. J., NOEBELS, H. J. and FAGERSON, I. S. Published by Academic Press Inc. 1958.

Contains a complete account of the papers presented and discussions which took place at the International Symposium on Gas Chromatography under the auspices of the Instrument Society of America at Michigan State University, 28-30 August, 1957. The papers presented will be found under the names of the first authors. See references 71, 152, 260, 313, 386, 453, 527, 608, 629, 641, 758, 814, 857, 873, 949, 968, 981, 1021, 1023, 1031, 1073, 1147, 1148, 1155, 1295, 1296, 1433 and 1457.

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THE editorial committee considered that an effective index would form a vital part of this volume and that it should be adaptable for transfer to a card system. The information contained in the abstracts has, therefore, been classified according to the headings listed below. Subjects have only been indexed if they are of particular interest (e.g., carrier gases are indexed only if they form a special feature of the paper).

Section 2 (Theory), also includes the effects of variables on column characteristics, etc., and in Sections 5 and 6 where the abstract indicates quantitative analysis, the abstract number is printed in bold type.

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